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A CONTRIBUTION TO THE FLORA OF THE EASTERN ARM OF GREAT SLAVE LAKE, NORTHWEST TERRITORIES

GEORGE W. SCOTTER

Canadian Wildlife Service, 742 Federal Building, Edmonton, Alberta

INTRODUCTION

THE WRITER HAD THE OPPORTUNITY to study the effects of forest fires on the winter range of the barren-ground caribou (*Rangifer tarandus groenlandicus*) for the Canadian Wildlife Service of the Department of Northern Affairs and National Resources, during the summers of 1961 and 1962. Camp was moved approximately once each week with float-equipped aircraft. This permitted the collection of lichens, bryophytes, and vascular plants in some botanically unknown or scantily known regions. The collection of plants, however, was incidental to the major study. All specimens cited have been deposited in the herbarium of the Plant Research Institute, Canada Department of Agriculture, at Ottawa. Duplicate material, where available, has been deposited in the herbaria of the Canadian Wildlife Service at Edmonton, and the National Museum of Canada at Ottawa.

BOUNDARIES OF THE STUDY AREAS

The study areas extended both north and south of the eastern arm of Great Slave Lake. The 1961 study area is located east of Yellowknife and extended from 111° to 113° 30′ W. long and from 63° 30′ N. lat. to the north shore of Great Slave Lake. The 1962 study area is in the Taltson River region, northeast of Fort Smith, and extended from 60° 50′ N. to 62° N. lat. and from 109° W. to 111° W. long. The collection sites were situated within small radii of the following locations:

1961 Collection Sites

Beniah Lake	63°25′ N.	112°20′ W.
Blachford Lake	62°12′ N.	113°30′ W.
Desperation Lake	62°35′ N.	112°15′ W.
Gordon Lake (north camp)	63°10′ N.	113°10′ W.
Gordon Lake (south camp)	62°58′ N.	113°12′ W.
Hearne Lake	62°20′ N.	113°08′ W.
Lac du Mort	63°05′ N.	111°15′ W.
Ross Lake	62°42′ N.	113°15′ W.
Thistlethwaite Lake	63°10′ N.	113°35′ W.
unnamed Lake	62°55′ N.	111°55′ W.

Mailing date of this number: 1 June, 1966

1962 Collection Sites

Gagnon Lake	61°55′ N.	110°10′ W.
Hjalmer Lake	61°35′ N.	109°25′ W.
Rutledge Lake	61°35′ N.	110°45′ W.
Taltson River (north camp)	61°50′ N.	109°10′ W.
Taltson River (south camp)	61°25′ N.	110°15′ W.
Thekulthili Lake	61°12′ N.	110°00′ W.
Whirlpool Lake	61°05′ N.	109°15′ W.

One lake is unnamed, and it is so designated.

The collection sites all lie within the Canadian Shield physiography. That portion of the Canadian Shield is of Precambrian age, and characteristic bedrock consists of various granites, diorites, slates, schists, andesites, and several other rocks.

Elevation of much of the region lies between 500 feet (Great Slave Lake) and about 2,000 feet. Locally, relief generally does not exceed 300 feet. Glaciation has produced a terrain consisting of small, but rather rugged hills with countless muskegs, bogs, and lakes in an intricate pattern at their bases.

The mineral soils of the study areas belong to the Sub-arctic region as defined by Nowosad and Leahey (1960). Those soils are classified as podzolic, gleysolic, or regosolic (Stobbe, 1960). Glacial drift and sand plains cover portions of the region.

CLIMATE

Meteorological stations at Yellowknife, Fort Reliance, and Fort Smith are located close to the collection areas, and data from these stations should generally be applicable to them (Table 1). The collection sites lie in the cold climatic zone. The winter climate is predominantly influenced by Arctic air masses. Summers are short and characterized by moderately warm temperatures and relatively long days. The area is in a low precipitation belt with rainfall and snowfall diminishing northward. More detailed climatic data has been reported by Kendrew and Currie, 1955.

TABLE 1.—Long-term climatic data from Yellowknife, Fort Reliance, and Fort Smith

	Location		
	Yellowknife	Fort Reliance	Fort Smith
Mean temperature — January (F)	−14.7	−23.9	−13.4
Mean temperature — July (F)	60.9	55.3	61.2
Mean total precipitation (inches)	8.45	8.28	12.63
Mean annual snowfall (inches)	34.5	45.9	46.6
Average frost free period (days)	113	84	59

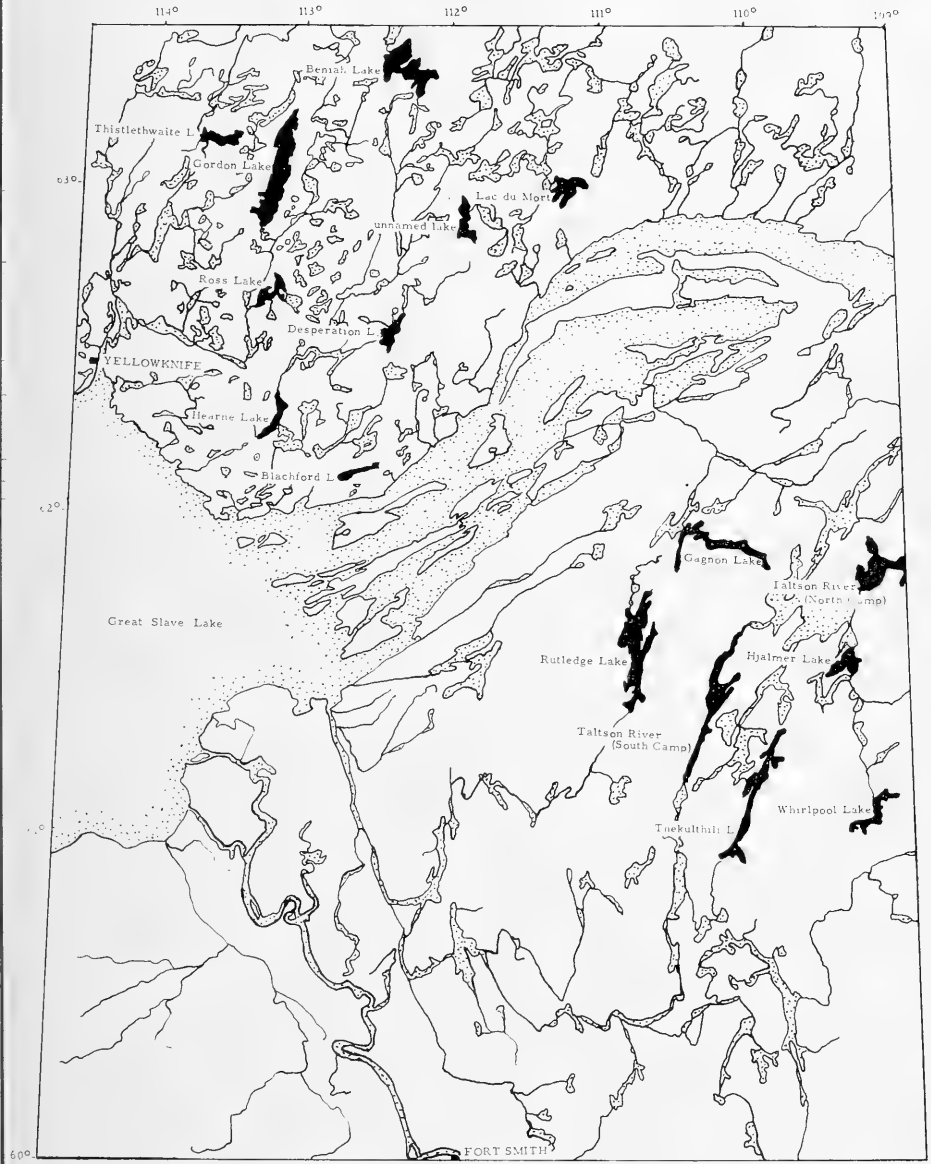

FIGURE 1. Map of the vicinity of the eastern arm of Great Slave Lake. Collection sites were located near the lake areas shown in solid black.

VEGETATION

With the exception of a narrow fringe in the northern study area, the collection sites fall within the Northwestern Transition Section (B. 27) of the transcontinental Boreal Forest Region (Rowe, 1959). The northern fringe is within the Forest-Tundra Section (B. 32) of the same Region. The most abundant tree on both upland and lowland sites is black spruce (*Picea mariana*). Better drained upland sites support white spruce (*Picea glauca*); tamarack (*Larix laricina*) is frequent in bogs and muskegs. Jack pine (*Pinus banksiana*) and white birch (*Betula papyrifera*) dominate the vast fire-destroyed tracts. The region is often referred to as "the land of little sticks" because an unfavorable climate, thin soil mantle, and forest fires tend to dwarf the tree growth. Lichens are an important component of the vegetal cover on shallow soils and rock outcrops.

PREVIOUS INVESTIGATIONS

The flora in the vicinity of the eastern arm of Great Slave Lake is not well known. Raup (1947) summarized the available information in his *Botany of Southwestern Mackenzie*. The study areas are in the eastern extremity of what Raup has defined as the Southwestern Mackenzie. Major publications which have contributed to our scant botanical knowledge of the study areas are those by Harper (1931) and Raup (1936). Other earlier contributions have been summarized by Raup (1946). Raup noted that most of the early collections were made along marginal strips of the major waterways and that the vast inland area was virtually unknown to botanists. Since the publication of Raup's work in 1947, Cody (1956, 1960, 1961, 1963), Jeffrey (1961), and Thieret (1961a, 1961b, 1962, 1963, 1964) have added considerably to the knowledge of the vascular flora in the western portion of the region.

ACKNOWLEDGMENTS

Grateful acknowledgment is made to the staff of the Plant Research Institute, Canada Department of Agriculture, and to Dr. A. E. Porsild, National Museum of Canada, for the identification or verification of the identity of many of the plants in the collection.

ANNOTATED LIST OF SPECIES

Cryptogramma crispa (L.) R. Br. v. *acrostichoides* (R. Br.) Clarke. Fairly common in rock crevices. Hearne L. 915a; Thekulthili L. 3081; Gagnon L. 3082.

Cystopteris fragilis (L.) Bernh. At the base of a rock ledge on an island. Rare. Lac du Mort 1141.

Dryopteris fragrans (L.) Schott. Fairly common near exposed seepage areas. Lac du Mort 1126, 1127; Beniah L. 1159, 1173; N. Gordon L. 1244; Thistlethwaite L. 1272a; S. Taltson R. 3083.

Dryopteris robertiana (Hoffm.) Christens. Occasional in rocky crevices in the northern region. Blachford L. 978; Lac du Mort 1142.

Polypodium virginianum L. Scarce on rock and in white birch forests. Thistlethwaite L. 1251; Ross L. 1304; Rutledge L. 3084.

Woodsia ilvensis (L.) R. Br. Scarce on dry rocky sites. Hearne L. 889; Beniah L. 1167.

Equisetum arvense L. Common along streams and in meadows. Hearne L. 893; Blachford L. 1006b; Beniah L. 1169; S. Taltson R. 3034.

Equisetum fluviatile L. Common in shallow water of lakes and streams. Blachford

FIGURE 2. Black spruce composes the dominant forest type throughout much of the region.

L. 1008; Desperation L. 1042; Lac du Mort 1109; Whirlpool L. 3035.

Equisetum scirpoides Michx. Common in muskegs and in moist forest sites. Blachford L. 975; N. Gordon L. 1230; S. Taltson R. 3033.

Equisetum sylvaticum L. Common in moist forest sites and in muskegs. Hearne L. 944, 959; Lac du Mort 1116; N. Gordon L. 1238; S. Taltson R. 3032.

Lycopodium annotinum L. Common in forests and in muskeg sites. Desperation L. 1050; unnamed L. 1063, 1068; Lac du Mort 1106; Ross L. 1303; N. Taltson R. 3078.

Lycopodium complanatum L. Frequent in mature forests. unnamed L. 1071, 1076, 1091a; N. Taltson R. 3079.

Lycopodium obscurum L. Frequent in forested sites. unnamed L. 1091b.

Lycopodium obscurum v. *dendroideum* (Michx.) D. C. Eat. Frequent in black spruce forests. N. Taltson R. 3077; Gagnon L. 3080.

Juniperus communis L. v. *depressa* Pursh. Fairly common on open slopes. Hearne L. 890; Thistlethwaite L. 1267; Gagnon L. 3094.

Juniperus horizontalis Moench. Scarce on rocky sites in the northern area. Blachford L. 1009; Thistlethwaite L. 1268.

Larix laricina (Du Roi) K. Koch. A common tree on muskegs sites. Blachford L. 991; Hjalmar L. 3093.

Picea glauca (Moench) Voss. Common on eskers. Blachford L. 984; Beniah L. 1186.

Picea mariana (Mill.) BSP. The most abundant tree in the region. Sight records only.

Pinus banksiana Lamb. Abundant on sandy and rocky sites in fire disturbed areas. Desperation L. 1052.

Sparganium minimum (Hartm.) Fries. Scarce in shallow water of lakes and streams. Beniah L. 1196; Thistlethwaite L. 1254.

Sparganium multipedunculatum (Morong) Rydb. Rare in shallow portions of lakes. Thistlethwaite L. 1261.

Potamogeton alpinus Balbis v. *tenuifolius* (Raf.) Ogden. Scarce in shallow water. Lac du Mort 1111; unnamed L. 1165.

Potamogeton gramineus L. Scarce in shallow bays and on moist terrestrial sites. N. Gordon L. 1241, 1245.

Potamogeton richardsonii (Benn.) Rydb. Found in a sheltered portion of the river. Scarce. S. Taltson R. 3202.

Triglochin maritima L. Scarce in shallow water of lakes and streams. Beniah L. 1166; Thistlethwaite L. 1263; Ross L. 1308a; S. Taltson R. 3151.

Agropyron subsecundum (Link) Hitchc. Rare. Collected near an old cabin site. Thekulthili L. 3052. (det. Porsild).

Agropyron trachycaulum (Link) Malte. Rare along rocky river bank. S. Taltson R. 3065. (det. Porsild).

Agrostis scabra Willd. Scarce in rocky sites and in recently burned-over areas. Beniah L. 1212; N. Gordon L. 1219b; S. Taltson R. 3064.

Alopecurus aequalis Sobol. Rare on a rocky lake shore and on a moist site in a recently burned-over area. Beniah L. 1200; Thekulthili L. 3057.

Calamagrostis canadensis (Michx.) Beauv. Fairly common in several habitats. unnamed L. 1085; Beniah L. 1180; N. Gordon L. 1222; Hjalmar L. 3060; S. Taltson R. 3063, 3070.

Calamagrostis inexpansa A. Gray. Rare on rocky hillsides. Lac du Mort 1139; Ross L. 1306.

Calamagrostis neglecta (Ehrh.) Gaertn. Rare on a recent burn and along a rocky lake shore. Ross L. 1301; Thekulthili L. 3056.

Calamagrostis purpurascens R. Br. Fairly common in several habitats. Hearne L. 894; unnamed L. 1094; Lac du Mort 1148; Beniah L. 1183, 1184.

Deschampsia caespitosa (L.) Beauv. Scarce on rocky shorelines. N. Taltson R. 3061; S. Taltson R. 3071.

Festuca brachyphylla Schultes. Frequent along the lake shore. Gordon L. 1249. (det. Porsild).

Festuca saximontana Rydb. Fairly common in several habitats. Desperation L. 1058; Beniah L. 1198; Ross L. 1286; S. Taltson R. 3067.

Glyceria borealis (Nash) Batchelder. Rare on a sandy beach. This collection represents the second report from the District of Mackenzie (Thieret, 1962). Thekulthili L. 3053.

Hierochloë odorata (L.) Beauv. Fairly common on sandy beaches. Hearne L. 926; Ross L. 1287; Gagnon L. 3074.

Hordeum jubatum L. Rare on disturbed sites. S. Gordon L. 1277; Thekulthili L. 3055.

Oryzopsis pungens (Torr.) Hitchc. Scarce on a rock outcrop. S. Taltson R. 3066.

Poa alpigena (Fr.) Lindm. A few plants were present on a sand bar near the lake shore. Beniah L. 1168. (det. Porsild).

Poa glauca Vahl. Common in several habitats. Hearne L. 901, 930, 938; Blachford L. 1016; Desperation L. 1035b, 1054, 1057; Lac du Mort 1123; Beniah L. 1189, 1199, 1202; N. Gordon L. 1236, 1250; Thistlethwaite L. 1262; Gagnon L. 3073.

Poa interior Rydb. Rare in forest openings and along river banks. N. Taltson R. 3062; S. Taltson R. 3069.

Trisetum spicatum (L.) Richter v. *maidenii* (Gand.) Fern. Rare on rock outcrops. N. Gordon L. 1225; Thekulthili L. 3054; S. Taltson R. 3068. (det. Porsild).

Carex aenea Fern. Fairly common in recently burned-over areas and occasional in mature forests. Lac du Mort 1118; Beniah L. 1182; Rutledge L. 3008; Whirlpool L. 3022.

Carex aquatilis Wahlenb. A common plant in areas with shallow water. Hearne L. 932; unnamed L. 1083, 1087; Beniah L. 1176; Thekulthili L. 3023.

Carex brunnescens (Pers.) Poir. Fairly common in recently burned-over forests and on rock outcrops. unnamed L. 1061; Lac du Mort 1119, 1143; Beniah L. 1194, 1204; Gagnon L. 3003; Rutledge L. 3006.

Carex buxbaumii Wahlenb. Along a rocky lake shore. Ross L. 1312.

Carex canescens L. Scarce in wet meadows and muskegs. unnamed L. 1074; Hjalmar L. 3021.

FIGURE 3. (Above). Jack pine forests are found on some well-drained sandy sites.

FIGURE 4. (Below). Dense carpets of lichens, such as this *Cladonia alpestris*, are present in mature upland forests. Lichens provide the principle winter fodder of barren-ground caribou.

FIGURE 5. Boulder pavements periodically flooded along rivers are a favourable habitat for wild chives, *Allium schoenoprasum* v. *sibiricum*. Photographed on the bank of the Taltson River.

Carex capillaris L. Rare on a rock outcrop and near a lake shore. Blachford L. 1005; Lac du Mort 1140.

Carex capitata L. Scarce in moist sites. unnamed L. 1066; Ross L. 1314; S. Taltson R. 3015.

Carex deflexa Hornem. Frequent in recently burned-over areas. Hearne L. 937; Beniah L. 1209; Gagnon L. 3000, 3002.

Carex disperma Dewey. Rare in a moist white birch forest. Thistlethwaite L. 1255; N. Taltson R. 3020. (det. Porsild).

Carex foenea Willd. Scarce on sandy beaches. S. Taltson R. 3011; Hjalmar L. 3059.

Carex garberi Fern. Rare in a moist depression within a mature black spruce forest. N. Gordon L. 1232.

Carex glacialis Mack. Rare on sandy areas. Lac du Mort 1146.

Carex gynocrates Wormsk. Scarce on a small island. Thekulthili L. 3038.

Carex lenticularis Michx. Occasional on rocky shorelines. Lac du Mort 1145.

Carex leptalea Wahlenb. Scarce in moist portions of a mature birch forest. N. Taltson R. 3018.

Carex limosa L. Occasional in wet muskegs. Ross L. 1344.

Carex loliacea L. Scarce in moist forested areas. unnamed L. 1089.

Carex media R. Br. Fairly common on moist sites. Blachford L. 1006a; Desperation L. 1045; Lac du Mort 1132, 1144; Ross L. 1311; S. Taltson R. 3014.

Carex paupercula Michx. Scarce on the edge of muskegs and in mature birch forests. unnamed L. 1065; Beniah L. 1153; N. Taltson R. 3017.

Carex physocarpa Presl. Fairly common in muskegs and along shorelines. unnamed L. 1067, 1088; Beniah L. 1161, 1201; S. Taltson R. 3009, 3010; N. Taltson R. 3019; Thekulthili L. 3025.

Carex rostrata Stokes. Fairly common in shallow water of lakes. Lac du Mort 1110.

Carex rotundata Wahlenb. Scarce in muskeg sites. Lac du Mort 1100, 1101; Beniah L. 1179; S. Taltson R. 3016.

FIGURE 6. Forest fires ravage large portions of the northern forests.

Carex stans Drej. Fairly common in moist regions. Lac du Mort 1098, 1104, 1138.

Carex supina Wahlenb. Frequent on sandy beaches and esker ridges. Hearne L. 885; unnamed L. 1073; S. Taltson R. 3012.

Carex tenuiflora Wahlenb. Scarce on eskers and near lake shores. unnamed L. 1095; Beniah L. 1154.

Carex vaginata Tausch. Scarce in muskegs and in mature white birch forests. Desperation L. 1041; Beniah L. 1162; Gagnon L. 3004; S. Taltson R. 3013.

Carex viridula Michx. Occasional on rocky lake shores. N. Gordon L. 1221; Rutledge L. 3007; Thekulthili L. 3024, 3026.

Eleocharis acicularis (L.) R. & S. Rare on clay soil. Rutledge L. 3027.

Eleocharis palustris (L.) R. & S. Frequent in shallow water. S. Taltson R. 3028.

Eriophorum angustifolium Honckeny. Fairly common in moist muskeg sites. Desperation L. 1032; Lac du Mort 1137; Rutledge L. 3030.

Eriophorum russeolum Fr. v. *albidum* Nyl. Rare in moist muskeg sites. Blachford L. 989, 1011.

Eriophorum vaginatum L. Sparse in moist peat sites. Lac du Mort 1096; Beniah L. 1160, (det. Porsild); Gagnon L. 3029.

Scirpus hudsonianus (Michx.) Fern. Infrequent in muskegs and along rivers. Blachford L. 1012, 1013; S. Taltson R. 3031.

Juncus alpinus Vill. v. *rariflorus* Hartm. Scarce along the rocky shoreline. Ross L. 1284.

Juncus balticus Willd. Scarce in moist pockets near shorelines. Blachford L. 1004.

Juncus balticus Willd. v. *alaskanus* (Hult.) Porsild. Sparse in moist pockets along the lake shore. Blachford L. 976. (det. Porsild).

Juncus filiformis L. Rare on the lake shore. Beniah L. 1155.

Juncus vaseyi Engelm. Scarce in moist sites. Hjalmar L. 3036. (det. Porsild).

Luzula confusa Lindebl. Rare in a recent burn. Beniah L. 1187.

Luzula wahlenbergii Rupr. Rare on the lake shore. Lac du Mort 1136.

Allium schoenoprasum L. v. *sibiricum* (L.) Hartm. Scarce in shallow water of lakes and moist pockets near lake shores. Hearne L. 925; Desperation L. 1030; S. Taltson R. 3085.

Smilacina trifolia (L.) Desf. Scarce in peat sites. Ross L. 1298a; S. Taltson R. 3087; Gagnon L. 3088; Rutledge L. 3089.

Tofieldia pusilla (Michx.) Pers. Fairly common in peat sites. Desperation L. 1031, 1043; Lac du Mort 1097; S. Taltson R. 3086.

Sisyrinchium montanum Greene. Scarce on a small island. Thekulthili L. 3037.

Habenaria obtusata (Pursh) Richards. Occasional in a drainage area forested with mature white spruce – white birch – black spruce. S. Taltson R. 3091.

Orchis rotundifolia Banks. Occasional in moist pockets in mature forests. Desperation L. 1046; S. Taltson R. 3092.

Spiranthes romanzoffiana Cham. & Schl. Scarce in peat sites. Beniah L. 1191; N. Gordon L. 1242; Hjalmar L. 3090.

Populus balsamifera L. Scarce along lake shores. Individual plants seldom exceeding 5 feet in height. Blachford L. 1007.

Populus tremuloides Michx. Frequent along portions of the Taltson River. S. Taltson R. 3051.

Salix arctophila Cockerell. Sparse near shores of an island and the lake. Lac du Mort 1133. (det. Porsild).

Salix arbusculoides Anderss. Frequent in shallow waters and along lake shores. Hearne L. 934, 963a; S. Taltson R. 3047.

Salix athabascensis Raup. Sparse on a sandy beach. Thekulthili L. 3049. (det. Porsild).

Salix bebbiana Sarg. Frequent in several habitats. Hearne L. 904a, 905, 949; Blachford L. 996, 1002, 1029; Beniah L. 1158, 1172; Rutledge L. 3040; S. Taltson R. 3044; Hjalmar L. 3048.

Salix candida Fluegge. Rare on the shoreline. Hearne L. 947.

Salix glauca L. This is a common willow in the northern study area. Hearne L. 950, 965; Blachford L. 971; unnamed L. 1084; Lac du Mort 1107, 1120, 1125, 1128, 1131; Beniah L. 1157, 1170, 1171, 1178; N. Gordon L. 1220; Thistlethwaite L. 1270; S. Taltson River 3046.

Salix myrtillifolia Anderss. Widespread in varied habitats. Hearne L. 904b, 962a; unnamed L. 1077; Lac du Mort 1190; Rutledge L. 3042; S. Taltson R. 3045.

Salix pedicellaris Pursh v. *hypoglauca* Fern. Infrequent in muskegs. Blachford L. 1010; unnamed L. 1078.

Salix planifolia Pursh. Frequent on rocky slopes and lake shores. Hearne L. 906; Gagnon L. 3039; Rutledge L. 3041.

Salix pyrifolia Anderss. Infrequent in varied habitats. Hearne L. 939, 964, 967; N. Gordon L. 1248; Rutledge L. 3043.

Salix scouleriana Barratt v. *coetanea* Ball. Rare in a moist depression near the lake shore. Hearne L. 955.

Salix serissima (Bailey) Fern. Rare on the lake shore. Hearne L. 943.

Myrica gale L. Frequently found bordering lake shores and muskegs. Hearne L. 911, 963a; S. Taltson R. 3075.

Alnus crispa (Ait.) Pursh. Common in upland forests. Hearne L. 907; unnamed L. 1092; Lac du Mort 1103; Hjalmar L. 3097.

Alnus tenuifolia Nutt. Scarce along lake shores and streams. Hearne L. 902; Thekulthili L. 3096.

Betula glandulosa Michx. Frequent along lake shores and other moist sites. Hearne L. 908; Desperation L. 1047; unnamed L. 1059, 1072; Lac du Mort 1152.

Betula occidentalis Hook. Few on a sandy esker. Gagnon L. 3095. (det. Porsild).

Betula papyrifera Marsh. Abundant in burned-over forests and along drainage channels. unnamed L. 1060; Lac du Mort 1149, 1150.

Betula pumila L. v. *glandulifera* Regel. Frequent in moist locations. Blachford L. 990; unnamed L. 1062.

Urtica gracilis Ait. Rare on an island near the center of the lake. Blachford L. 980.

Geocaulon lividum (Richards.) Fern. Widespread in mature upland forests. unnamed L. 1086; N. Taltson R. 3098.

Polygonum lapathifolium L. Rare on a rock outcrop in a jack pine forest. Ross L. 1310.

FIGURE 7. (Left). Pale corydalis (*Corydalis sempervirens*), and fireweed (*Epilobium angustifolium*), which quickly springs from perennial roots, are early invaders following forest fires.

FIGURE 8. (Right). White birch is often the pioneer tree species taking over following fires in the black spruce forests.

Rumex occidentalis S. Wats. Rare on a sandy beach. Only two plants were found. Thekulthili L. 3099.

Chenopodium capitatum (L.) Aschers. Rare on disturbed soils. S. Gordon L. 1278; Thekulthili L. 3100.

Arenaria dawsonensis Britt. Rare in young birch forests and in a recently burned-over forest. Blachford L. 1000; Ross L. 1290.

Arenaria macrophylla Hook. The sole occurrence was in an open birch forest. S. Taltson R. 3210. (det. Porsild).

Cerastium alpinum L. Rare in a young birch forest. Blachford L. 987.

Stellaria calycantha (Ledeb.) Bong. Rare on a rocky shoreline. N. Gordon L. 1229.

Stellaria longifolia Muhl. Infrequent in a young jack pine forest, on rock outcrops, and on sandy beaches. Hearne L. 917; Rutledge L. 3112; Gagnon L. 3114.

Stellaria monantha Hultén. Infrequent on a sandy beach. Beniah L. 1210.

Stellaria subvestita Greene. Sparse on a rocky ledge in a mature black spruce forest. Gordon L. 1235. (det. Porsild).

Nuphar variegatum Engelm. Fairly common in shallow water of a lake and river. unnamed L. 1093; S. Taltson R. 3101.

Anemone multifida Poir. v. *hudsoniana* DC. Scarce in open forests. Hearne L. 919; Blachford L. 995; Beniah L. 1208; S. Taltson R. 3103.

Anemone patens L. v. *multifida* Pritzel. Scarce in an open jack pine forest. Gagnon L. 3105.

Anemone richardsonii Hook. Rare in a moist birch stand. Thistlethwaite L. 1252.

Aquilegia brevistyla Hook. Rare on rocky shorelines. Blachford L. 974; S. Taltson R. 3104.

Ranunculus flammula L. Scarce along lake shores. Beniah L. 1156; Thistlethwaite L. 1259; S. Taltson R. 3102.

Ranunculus gmelinii DC. v. *hookeri* (D. Don) L. Benson. Rare in very shallow water near a stream outlet. Desperation L. 1070.

Ranunculus lapponicus L. Scarce in peaty areas. Desperation L. 1044, 1049; N. Gordon L. 1231; Gagnon L. 3106.

Ranunculus subrigidus Drew. Abundant in shallow water at this one location. Thekulthili L. 3201. (det. Porsild).

Corydalis sempervirens (L.) Pers. One of the most common plants in recently burned-over areas. Hearne L. 922; Lac du Mort 1114; Ross L. 1293; Gagnon L. 3109.

Arabis retrofracta Graham. Scarce in an open jack pine forest and on rocky outcrops. Hearne L. 912, 954; Ross L. 1037a; Gagnon L. 3115.

Barbarea orthoceras Ledeb. Scarce along sandy and rocky lake shores. Ross L. 1288, 1300; Rutledge L. 3113.

Cardamine parviflora L. v. *arenicola* (Britt.) O. E. Schulz. Rare in a recently burned-over area and on an open north slope. Ross L. 1295; S. Taltson R. 3110.

Descurainia sophioides (Fisch.) O. E. Schulz. Rare near an abandoned mine. S. Gordon L. 1276.

Rorippa islandica (Oeder) Borbas. Scarce in moist depressions along lake shores. Hearne L. 933; Beniah L. 1217b; Thekulthili L. 3217.

Drosera rotundifolia L. A few plants were found at the edge of a muskeg. S. Gordon L. 1280.

Parnassia kotzebuei Cham. & Schl. A few plants were collected on one small island. N. Gordon L. 1228.

Parnassia palustris L. Frequent in moist sites and along lake shores. Ross L. 1291; S. Gordon L. 1282; Whirlpool L. 3123, 3128; Hjalmar L. 3124.

Ribes glandulosum Grauer. Scarce in young birch forests. Hearne L. 945; Blachford L. 1024.

Ribes hudsonianum Richards. Scarce in young birch forests and along openings near lake shores. Hearne L. 952; Thistlethwaite L. 1265; Thekulthili L. 3116; Hjalmar L. 3119; S. Taltson R. 3120.

Ribes oxyacanthoides L. Scarce on open rocky slopes. Blachford L. 977; Ross L. 1309; S. Taltson R. 3121.

Ribes triste Pall. Scarce in moist sites of mature forests. Thekulthili L. 3117; Whirlpool L. 3118.

Saxifraga tricuspidata Rottb. Frequent in the southern region and scarce in the northern region. Hearne L. 897; Rutledge L. 3125; Gagnon L. 3127.

Saxifraga tricuspidata Rottb. f. *subintegrifolia* (Abromeit) Polunin. Scarce along rock outcrops and in open jack pine forests. Hearne L. 914; Rutledge L. 3122.

Amelanchier alnifolia Nutt. Frequent in forest openings. Hearne L. 924; Blachford L. 981, 982; S. Taltson R. 3133.

Fragaria glauca (S. Wats.) Rydb. Rare on a rocky slope. Hearne L. 915b.

Potentilla arguta Pursh. Rare in a recently burned-over area. Blachford L. 1022.

Potentilla fruticosa L. Frequent in several habitats. Hearne L. 935; Blachford L. 983, 994; Ross L. 1297, 1307b.

Potentilla multifida L. Sparse along lake shores. N. Gordon L. 1219a; S. Taltson R. 3139.

Potentilla nivea L. ssp. *hookeriana* (Lehm.) Hiitonen. Frequent in several habitats. Hearne L. 920, 942; Blachford L. 986, 1018, 1025a; Beniah L. 1214.

Potentilla norvegica L. Frequent on sandy beaches and along rocky lake shores. Beniah L. 1181; Ross L. 1296b; Thekulthili L. 3136; Rutledge L. 3141; Gagnon L. 3142.

Potentilla palustris (L.) Scop. Frequently growing in shallow water and in moist regions with mature white birch. Blachford L. 1025b; Desperation L. 1033; Beniah L. 1164; Thistlethwaite L. 1253; Hjalmar L. 3138.

Potentilla tridentata Ait. Rare on a rock outcrop. Whirlpool L. 3137.

Prunus pensylvanica L.f. Scarce in recently burned-over areas and on rock outcrops. Blachford L. 970; Rutledge L. 3134, 3135.

Rosa bourgeauiana Crépin. Frequent in open and in aspen forests. Hearne L. 888; N. Gordon L. 1223, 1234; Thistlethwaite L. 1258; S. Taltson R. 3132.

Rubus acaulis Michx. Scarce in black spruce muskegs and in other moist areas. Hearne L. 918; Gagnon L. 3143.

Rubus chamaemorus L. Frequent on peaty sites. Hearne L. 896, 916; Lac du Mort 1129; Gagnon L. 3144.

Rubus strigosus Michx. Frequent on burned-over areas and on rock outcrops. Hearne L. 913; N. Taltson R. 3129; S. Taltson R. 3131; Rutledge L. 3140. (det. Porsild).

Astragalus yukonis M. E. Jones. Rare in forest opening. Hearne L. 961.

Hedysarum alpinum L. v. *americanum* Michx. Rare in a birch forest. Blachford L. 997.

Oxytropis splendens Dougl. Rare on recently burned-over areas and on sandy eskers. Blachford L. 1020; Hjalmar L. 3145.

FIGURE 9. (Above). Unstable slopes are colonized by prostrate shrubs such as *Arctostaphylos uva-ursi* and *Empetrum nigrum*.

FIGURE 10. (Below). Sedge bogs, although not common in the region, provide valuable wildlife habitat.

FIGURE 11. The Labrador tea, *Ledum groenlandicum,* is encountered on upland sites as well as in muskegs throughout most of the northern coniferous forests.

Oxytropis viscida Nutt. Rare in a burned-over area and on a rock outcrop. Beniah L. 1211, 1215.

Geranium bicknellii Britt. Rare in a recently burned-over area. Rutledge L. 3169.

Callitriche verna L. Rare in shallow water of a sheltered bay. Beniah L. 1203.

Empetrum nigrum L. Common throughout the region. Hearne L. 894; Lac du Mort 1102; Ross L. 1305; Thekulthili L. 3050.

Viola palustris L. Rare in a moist birch forest site. unnamed L. 1080.

Shepherdia canadensis (L.) Nutt. Common along margins of lakes, marshes, and muskegs. Hearne L. 891; N. Gordon L. 1224; Thekulthili L. 3146; S. Taltson R. 3147.

Epilobium angustifolium L. Frequent in recently burned-over forests and on rock outcrops. Lac du Mort 1105, 1108, 1115, 1121; unnamed L. 1064; S. Taltson R. 3150.

Epilobium glandulosum Lehm. v. *adenocaulon* (Haussk.) Fern. Rare in a recently burned-over area and on a rocky island. Ross L. 1296a; Thekulthili L. 3148.

Epilobium palustre L. Rare in a jack pine forest. Ross L. 1313.

Hippuris vulgaris L. Scarce in shallow water of lakes and streams. Desperation L. 1036; Lac du Mort 1124, 1147.

Cicuta mackenzieana Raup. Scarce along stream banks and lake shores. Thistlethwaite L. 1264; Whirlpool L. 3152.

Cornus canadensis L. Locally abundant. Hearne L. 928; S. Taltson R. 3154.

Cornus stolonifera Michx. Rare along the bank of a small stream. Hjalmar L. 3153.

Pyrola grandiflora Radius. Frequent in moist forests. Hearne L. 921, 948; Gagnon L. 3157.

Pyrola minor L. Rare in moist habitats. Beniah L. 1206; Whirlpool L. 3155. (det. Porsild).

FIGURE 12. (Above). Recurring fires have undoubtedly facilitated the establishment and spread of Jack pine forests in the region.

FIGURE 13. (Below). Eskers are a prominent feature of the landscape. Looking along the esker to Lac du Mort its direction runs northeast-southwest. The camp tents are visible in the upper left of the picture.

Pyrola secunda L. Scarce in moist habitats. Hearne L. 951; N. Gordon L. 1237; S. Taltson R. 3156.

Andromeda polifolia L. Frequent in open muskegs. Hearne L. 899; Gagnon L. 3158.

Arctostaphylos rubra (Rehder & Wils.) Fern. Frequent in moist lowlands and muskegs. Hearne L. 910; unnamed L. 1090; Beniah L. 1174; S. Taltson R. 3167.

Arctostaphylos uva-ursi (L.) Spreng. Common on sandy slopes and eskers. Hearne L. 898b, 900.

Chamaedaphne calyculata (L.) Moench. Frequent bordering lakes and muskegs. Hearne L. 909; unnamed L. 1082; Gagnon L. 3159.

Kalmia polifolia Wang. Scarce in open muskegs. Gagnon L. 3162.

Ledum groenlandicum Oeder. Abundant in lowland and upland forest sites. Hearne L. 892; Gagnon L. 3161.

Ledum palustre L. v. *decumbens* Ait. Frequent on uplands and drier lowlands. Lac du Mort 1134; Gagnon L. 3160.

Loiseleuria procumbens (L.) Desv. Fairly frequent in the northern region, but noted only twice in the southern region. unnamed L. 1075; Lac du Mort 1099; Beniah L. 1195; N. Taltson R. 3168.

Oxycoccus quadripetalus Gilib. Frequent in wet muskegs. Lac du Mort 1130. (det. Porsild).

Rhododendron lapponicum (L.) Wahlenb. Rare in muskeg sites. Desperation L. 1040; N. Gordon L. 1233.

Vaccinium uliginosum L. Frequent in moist lowlands. Blachford L. 1026; S. Taltson R. 3165.

Vaccinium vitis-idaea L. v. *minus* Lodd. Abundant throughout both regions. Hearne L. 898a; Blachford L. 993; Rutledge L. 3164; S. Taltson R. 3166.

Androsace septentrionalis L. Sparse on a recently burned-over area and on open slopes. Hearne L. 895; Ross L. 1292; Gagnon L. 3126.

Lysimachia thyrsiflora L. Rare in shallow water of lakes. Ross L. 1345; Whirlpool L. 3205.

Primula stricta Hornem. A few plants were collected on the shore of an island. Blachford L. 1027.

Menyanthes trifoliata L. Common in shallow water of lakes. S. Gordon L. 1279; N. Gordon L. 1239; Gagnon L. 3204; N. Taltson R. 3209.

Phacelia franklinii (R. Br.) A. Gray. Frequent in recently burned-over forests. Hearne L. 957; Thekulthili L. 3170; Rutledge L. 3171; Gagnon L. 3172; Hjalmar L. 3208.

Dracocephalum parviflorum. Nutt. Scarce on rock outcrops. Beniah L. 1216; Hjalmar L. 3130.

Lycopus uniflorus Michx. Rare in rock crevices near the lake shore. New to the flora of the District of the Mackenzie. Thekulthili L. 3207.

Mentha arvensis L. v. *villosa* (Benth.) S. R. Stewart. Frequent in rock crevices near lake shores in the southern region, but not noted in the northern regions. Thekulthili L. 3076, 3108; Hjalmar L. 3107.

Castilleja raupii Pennell. Rare on a dry peat site. Blachford L. 1001.

Pedicularis labradorica Wirsing. Frequent in lowland forests and in muskeg sites. Desperation L. 1038; unnamed L. 1069; Beniah L. 1163, 1185; Ross L. 1281; Hjalmar L. 3173; N. Taltson R. 3174; S. Taltson R. 3175.

Veronica peregrina L. v. *xalapensis* (HBK.) St. John & Warren. Rare on a moist site. Beniah L. 1218b.

Veronica scutellata L. Rare in a moist depression. Hjalmar L. 3149.

Pinguicula villosa L. Sparse on *Sphagnum.* Desperation L. 1048; Gagnon 3177.

Pinguicula vulgaris L. Rare in rock crevices on the lake shore. Desperation L. 1055.

Utricularia intermedia Hayne. Frequent in shallow water of sheltered areas. N. Gordon L. 1240; N. Taltson R. 3176.

Utricularia vulgaris L. Few in a small stagnant pond. Flowering material was collected. Thistlethwaite L. 1266, 1269.

Galium trifidum L. Scarce on gravelly lake shores. Thistlethwaite L. 1275; Thekulthili L. 3206.

Linnaea borealis L. v. *americana* (Forbes) Rehd. Frequent in jack pine forests and on rock outcrops. Hearne L. 941; Desperation L. 1037; S. Taltson R. 3176.

Viburnum edule (Michx.) Raf. Frequent on sandy soils and gravel ridges. Hearne L. 886; Beniah L. 1217a; Gagnon L. 3179.

Achillea lanulosa Nutt. Scarce in young birch forests and along river banks. Blachford L. 1003, 1017; S. Taltson R. 3186.

Achillea sibirica Ledeb. Scarce in recently burned-over forests, rock outcrops, and sandy beaches. Ross L. 1285, 1289; Rutledge L. 3183; Hjalmar L. 3196.

Antennaria campestris Rydb. v. *athabascensis* (Greene) Boivin. Sparse on a sandy beach. Gagnon L. 3180.

Antennaria canescens (Lge.) Malte. Sparse on rocky slopes. New to the flora of the Mackenzie district (Porsild, 1957). Desperation L. 1051. (det. Porsild).

Antennaria rosea (Eat.) Greene. Scarce in young birch stands and along sandy beaches. Blachford L. 988, 999; S. Taltson R. 3184.

Arnica alpina (L.) Olin ssp. *attenuata* (Greene) Maguire. Few on a recent burn. Gagnon L. 3181. (det. Porsild).

Arnica lonchophylla Greene. Frequent in forest openings and rock outcrops. Hearne L. 927; Blachford L. 998, 1023; Beniah L. 1197, 1213; Gagnon L. 3182.

Artemisia caudata Michx. Scarce along sandy river banks and beaches of lakes. S. Taltson R. 3198.

Artemisia caudata Michx. v. *douglasiana* (Besser) Boivin. Scarce on sandy beaches and rocky slopes near lake shores. Blachford L. 985; Desperation L. 1035a.

Erigeron angulosus Gaudin v. *kamtschaticus* (DC.) Hara. Scarce in sandy soil and on rock outcrops. Beniah L. 1188; Whirlpool L. 3197.

Erigeron elatus Greene. Rare on an open muskeg. Hjalmar L. 3194.

Hieracium canadense Michx. Scarce on rock outcrops. Ross L. 1308b; Hjalmar L. 3193, 3195.

Petasites palmatus (Ait.) A. Gray. Scarce on a forested muskeg and recently burned-over muskeg. unnamed L. 1081; Lac du Mort 1117.

Petasites sagittatus (Pursh) A. Gray. Scarce in a burned-over muskeg and in other moist depressions. Hearne L. 940; Blachford L. 1014; Gagnon L. 3200. (det. Porsild).

Senecio cymbalarioides Nutt. v. *borealis* (T. & G.) Greenm. Scarce in jack pine and birch forests. Hearne L. 887, 956; Blachford L. 1021; S. Taltson R. 3187.

Senecio indecorus Greene. Scarce on rock outcrops and forest openings. S. Taltson R. 3190; Hjalmar L. 3191; Rutledge L. 3199.

Solidago decumbens Greene v. *oreophila* (Rydb.) Fern. Scarce on sandy beaches, rock outcrops, and recently burned-over forests. Beniah L. 1205; S. Taltson R. 3188; Hjalmar L. 3192.

Taraxacum dumetorum Greene. Rare on a seepage area of a rock outcrop. S. Taltson R. 3185. (det. Porsild).

Taraxacum lacerum Greene. Rare on a rocky river bank. N. Taltson R. 3189. (det. Porsild).

SUMMARY

DURING the summers of 1961 and 1962, vascular plants were collected in the vicinity of the eastern arm of Great Slave Lake, Northwest Territories. A total of 749 collections were made which included 49 families, 121 genera, and 233 species. Among these *Lycopus uniflorus* Michx. and *Antennaria canescens* (Lge.) Malte are believed to be new to the District of Mackenzie. Many other collections represent extensions of previously known ranges.

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FOOD HABITS OF THE LYNX IN ALBERTA AND THE MACKENZIE DISTRICT, N.W.T.

CONSTANTINUS G. VAN ZYLL DE JONG*
Department of Zoology, University of Alberta, Edmonton, Alberta

THIS PAPER PRESENTS information on the food habits of the Canada lynx, *Felis* (*Lynx*) *canadensis*. Only scattered observations of its food habits had been made prior to the detailed information presented in a recent paper on the food habits of the Newfoundland lynx (Saunders, 1963).

MATERIALS AND METHODS

The information was obtained from the stomach and gut contents of 75 animals. The material represents the period from November 1961 to May 1963. Most of the specimens (64) came from the Province of Alberta; the remainder from an area around Hay River and the region of the Lower

*Present Address: Department of Zoology, University of Toronto, Toronto, Ontario.

Rabbit Skin River, Mackenzie District, N.W.T. The lynx population was high and probably experienced its peak during the period of study.

The stomach and gut contents were saved in separate containers and perserved in 10 per cent formalin at the time of autopsy. The gut contents were later washed to clean out most superfluous fecal matter; hairs, feathers and all hard parts such as teeth, bone fragments and claws were saved for identification. Stomach contents presented little difficulty as prey species could usually be readily identified. Hairs were identified by comparison with whole mounts of known hairs, and impressions of their cuticular scale patterns with those of known hairs. The hairs were cleaned in carbon tetrachloride if necessary. Two or more hairs were then put on a cellulose acetate slide of the type normally used to make fish scale impressions. They were arranged in such a way that the base of some and the tips of others extended over the edge of the slide. A moderate amount of acetone was then lightly applied with the tip of a feather. The acetone dissolved the surface of the slide causing the hairs to sink in. After a few seconds, to allow the acetone to evaporate, the hairs were pulled off leaving a clear mold of the cuticular scales. Considerable variation exists in the cuticular scale pattern from the base to the tip of the hair. Comparison of all regions of the hair were made to arrive at a correct identification. Teeth, skeletal material, claws, feet, bills, etc., were identified by direct comparison with specimens in the collection of the Department of Zoology, University of Alberta. Stomach and gut samples from each individual were treated as one.

Results and Discussion

The results are expressed in Table 1. The small sample size made a breakdown into separate regions and seasons undesirable. The seasonal breakdown was limited to winter and summer, on the assumption that snowcover presents the most important ecological factor determining the availability of food (Formosov, 1946). The area covered by the survey is vast and variations exist as to first appearance and duration of snowcover. The divisions were therefore arbitrarily based on conditions in the central part of the area (Edmonton). The winter period extends from November to March (5 months); the summer period from April to October (7 months).

Not much is known about the relative abundance of the prey species during the period of investigation. Snowshoe hare (*Lepus americanus*) populations showed first signs of decrease, at least locally, in the summer of 1961 (Keith, personal communication), but hares were still plentiful during the winter of 1961-1962 and the following summer. The main decline seems to have occurred in central Alberta during the winter of 1962-1963, but was probably a year earlier in the Northwest Territories. In the spring of 1963 the hares were definitely "down" everywhere according to most informants. Microtines, grouse and red squirrels (*Tamiasciurus hudsonicus*) were considered to be relatively abundant during 1961 and 1962.

Mammals were the most important food in summer as well as winter. Five genera of mammals were found in the winter sample. The snowshoe hare was most frequently eaten, followed by *Microtus*. All the *Microtus* were recorded from the months of November and December, suggesting a decrease in avail-

ability with the increased depth and permanence of snowcover. Red squirrel and beaver (*Castor canadensis*) occurred once. Deer (*Odocoileus* sp.) was found on three occasions. It is impossible to say whether it was carrion or killed by the lynx itself. There is little doubt that a full grown lynx can successfully attack and kill, at least a small deer, particularly when favored by snow conditions.* Saunders (1963) reported an unsuccessful attack on a female caribou (*Rangifer tarandus*) and a number of alleged lynx kills of the same species. Sheppard (1960) reported a small mule deer (*Odocoileus hemionus*) killed by a lynx. Seton (1910) also reported deer killed by the lynx.

Birds are the second most important group after mammals. Grouse were most frequently eaten. In two cases the grouse could be identified with certainty as Ruffed Grouse (*Bonasa umbellus*). The other grouse remains probably belonged to the same species, but this could not be established with certainty. In all cases the grouse remains were associated with buds and catkins of deciduous trees or shrubs.

The birds listed as unidentified could not be determined because only a few feathers or fragments of feathers were found. Judging from the diameter of the shafts, they all appeared to be medium sized birds (the size of a crow or chicken). It is possible that some of the bird remains in this category originated from the bird wings frequently used as lures by trappers in this area.

The summer food habits showed a greater variety of prey species and decreased dependence on snowshoe hare. Microtines are more readily available during this season, and were found most frequently after snowshoe hare. Red squirrels were found twice, a rather low frequency if the relative abundance of this species is taken into consideration. Its quickness and alertness, as well as its partly arboreal habits probably reduce its availability as a lynx food. Richardson's ground squirrel (*Citellus richardsoni*), a species of the open plains was found once. The presence of this squirrel reflects the invasion of unusual habitats by the lynx during periods of high population pressure. The specimen containing the ground squirrel was collected near Calgary. One lynx collected at Gorge Creek contained three Columbian ground squirrels (*Citellus columbianus*).

The importance of birds in the summer food habits was witnessed by a higher overall occurrence, as well as a greater variety of species. Grouse had decreased in importance compared with the winter. Remains of a Gray Partridge (*Perdix perdix*) were found in an animal collected near Brooks. This, as was the case with Richardson's ground squirrel, also represents an unusual prey species. Two ducks were found, one of which could be identified as a Mallard (*Anas platyrhynchos*). The unidentified birds were represented by

*The weight-load, calculated for two winter animals, was 38 and 34 g/cm^2 of foot surface area. Similar figures for the Eurasian species (all taken from Yurgenson, 1955) are: 42 g/cm^2 (Pechora basin); 40-60 g/cm^2 (Altai); 34-39 g/cm^2 (Moscow region). These figures may suggest better adaption to snow conditions in the New World species. In this respect it should be noted that the measurements of the hind foot are greater in the Canada lynx than in the Eurasian species, although the latter is a much larger animal. Mean hind foot length for the Canada lynx is about 23 cm; the range in the European lynx is 19-22.5 cm. (van den Brink, 1955).

TABLE 1. — Analysis of 75 digestive tracts from the lynx

	Winter n = 52		Summer n = 23	
	Frequency of occurrence	% occurrence	Frequency of occurrence	% occurrence
Snowshoe hare	41	79	12	52
Microtus	5	10	5	22
Clethrionomys	–	–	2	9
Red squirrel	1	2	2	9
Richardson's ground squirrel	–	–	1	4
Columbian ground squirrel	–	–	1	4
Beaver	1	2	–	–
Deer	3	6	–	–
Total Mammals	45	86%	20	87%
Grouse	5	10	1	4
Gray Partridge	–	–	1	4
Duck	–	–	2	9
Unidentified bird	7	13	4	17
Total Birds	12	23%	8	35%
Grass	5	10	5	22

feathers or feather fragments, and in some cases bony parts and feet. In the majority of cases they seemed to have belonged to passerines.

Grass occurred in the digestive tract in winter and summer. The quantities eaten varied from two or three blades to a "handful" of grass. Captive lynxes were given fresh grass regularly during the summer. They apparently liked to eat it; different animals were observed on more than one occasion to leave their feeding tray when fresh grass was made available. Domestic cats and dogs eat grass but it is not known what benefit they derive from it, although it has been suggested that the scouring action would help reduce helminth infections. Grass was also recorded by Saunders (1963).

Only a general comparison of the food habits of western Canadian lynx with those of Newfoundland is possible (Saunders, 1963), because the Newfoundland survey is based on a much larger sample collected over a five year period.

Nine mammals are listed as prey of the lynx in Newfoundland, but only four are of common occurrence; snowshoe hare occurred in 73 per cent of the total sample; moose (*Alces alces*) in 15 per cent; *Microtus* in 14 per cent and caribou in 5 per cent.

In the present study eight kinds (in some cases one 'kind' may include two species, e.g., deer) of mammals were found The four most commonly occurring were: snowshoe hare in 71 per cent of the total sample, *Microtus* in 13 per cent, deer in 4 per cent and red squirrel in 4 per cent. In both areas the snowshoe hare is the most important food item in all seasons. The most striking

difference is the frequency occurrence of moose in Newfoundland, where it represents the second most frequent food item in three out of four seasons (believed to be carrion in most cases). Saunders (1963) pointed out that sampling bias was probably responsible for this. *Microtus* is the second most frequently encountered species in the summer. Caribou, next in importance, occurs in three out of four seasons. It occupies a place similar to that of deer in the present study, except that the latter has only been recorded in winter. Birds are about equally important in both areas; they occurred in 21 per cent of the total sample in Newfoundland and in 27 per cent of the total sample in Alberta. The main difference is the fairly high occurrence of grouse* (in 8 per cent of the total sample) and ducks (in 3 per cent of the total sample) in Western Canada. The most frequently occurring bird of comparable size in Newfoundland was the ptarmigan (*Lagopus* sp.), which occurred in 2 per cent of the total sample.

It appears that food availability, on which the success of the species depends is not appreciably different in the two areas. In the relatively varied fauna of the continent as well as in the impoverished insular fauna of Newfoundland, survival depends on a small number of species, especially during the critical winter season.

Food specialization in the Felidae is related primarily to size. A medium sized cat such as the lynx depends mainly on medium sized terrestrial prey. The small number of species that fits this description in the range of the Canada lynx explains the extreme dependence on the snowshoe hare. The lack of stability in lynx populations is closely linked with this dependence on one species. MacLulich (1937) demonstrated the existence of a correlation between numbers of snowshoe hare and lynx abundance. Yurgenson (1955) reported that the lynx numbers in the forests of the central zone of the USSR were relatively stable and fluctuated within narrow limits during a period of almost 20 years, (the high was 3 times the low). The fluctuations of the varying hare (*Lepus timidus*) during this period were of a much larger amplitude (the high was 12.5 times the low), although they affected the lynx population in the area, the predator-prey relationship was not a simple one. Negative and positive relationships were observed. This seems to suggest dependence on a greater variety of prey species. No food habit analysis was done in the area of study, but winter food analyses from other areas of the central zone of the USSR (Popov and Gavrin *in* Yurgenson, 1955) show a smaller proportion of hares and greater proportions of other prey species, than were found in North America. Small ungulates, such as roe deer (*Capreolus capreolus*) and musk deer (*Moschus* sp.) and the young of larger ungulates are important prey species in some areas, especially the mountainous regions of the USSR. I do not have any information on the stability of the lynx populations in these areas, but suspect them to be quite stable. Novikov (1956) said that sharp fluctuations do occur in the Soviet Union regionally, apparently in response to fluctuations in hare populations.

*Grouse do not occur in Newfoundland.

Summary

The contents of 75 digestive tracts from Canada lynx were analyzed. Snowshoe hare was found to be the most frequently occurring food item throughout the year (79 per cent in winter, 52 per cent in summer) followed by microtines (10 per cent in winter, 31 per cent in summer). Other mammals found were red squirrels, ground squirrels, beaver and deer. Birds occurred less frequently. Grouse and ducks were most important.

Acknowledgements

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THE *FESTUCA SCABRELLA* ASSOCIATION IN RIDING MOUNTAIN NATIONAL PARK, MANITOBA

DONALD A. BLOOD
Canadian Wildlife Service, Edmonton*

DURING RANGE MANAGEMENT studies carried out by the Canadian Wildlife Service in Riding Mountain National Park in 1961,1962, and 1963, data were collected on the composition and productivity of the *Festuca scabrella* (rough fescue) association, also called fescue prairie and fescue grassland. The association has been described in Alberta by Moss and Campbell (1947), in Saskatchewan by Coupland and Brayshaw (1953) and in North Dakota by Cosby (1965) Objectives of this paper are to bring attention to the occurrence of fescue prairie in Manitoba, to record its present status in Riding Mountain Park, and to compare its composition there with data presented by other investigators.

The occurrence in Manitoba of grasslands dominated by rough fescue does not appear to have been widely recognized, although collections of this species in the Province have been recorded in the taxonomic literature (Scoggan 1957). The grassland of southwestern Manitoba has received little attention from ecologists since Bird (1927, 1930) reported 35 years ago. In his discussion of the vegetation of the Aspen Parkland of western Canada Bird (1930) did not mention fescue prairie. His field observations were made primarily in southwestern Manitoba. The late recognition of fescue grassland there may be partially attributed to the infrequent production of culms by rough fescue, as suggested by Moss (1955) in Alberta.

Coupland (1961) stated that fescue prairie ". . . occupies the black soil between the clumps of *Populus tremuloides* in the aspen grove region along the north of the Mixed Prairie from central Saskatchewan westward to the Rocky Mountains and then extends southward . . . The community also occurs as an island within the Mixed Prairie region on the bench lands and upper slopes of the Cypress Hills . . ." To the east of central Saskatchewan *F. scabrella* evidently loses its dominance and other species become more important (Coupland and Brayshaw 1953). They stated that in southeastern Saskatchewan from the Canada-United States boundary to Yorkton, "Small areas dominated by *Stipa spartea* var. *curtiseta*, *Stipa comata* Trin. and Rupr., *Agropyron* spp. and *Bouteloua gracilis* (HBK.) Lag. alternate with communities in which *Festuca scabrella* and associates of the fescue community are abundant and with others in which species of the true prairie, notably *Andropogon scoparius*, are conspicuous."

Much of the grassland of Riding Mountain Park is presently grazed by domestic cattle and, according to Campbell et al. (1956) "Rough fescue is palatable and is grazed out fairly readily". Therefore it appears worthwhile to record the present distribution and composition of essentially pristine tracts of fescue prairie in that area.

*Present Address: British Columbia Fish and Game Branch, Court House, Nanaimo, B.C.

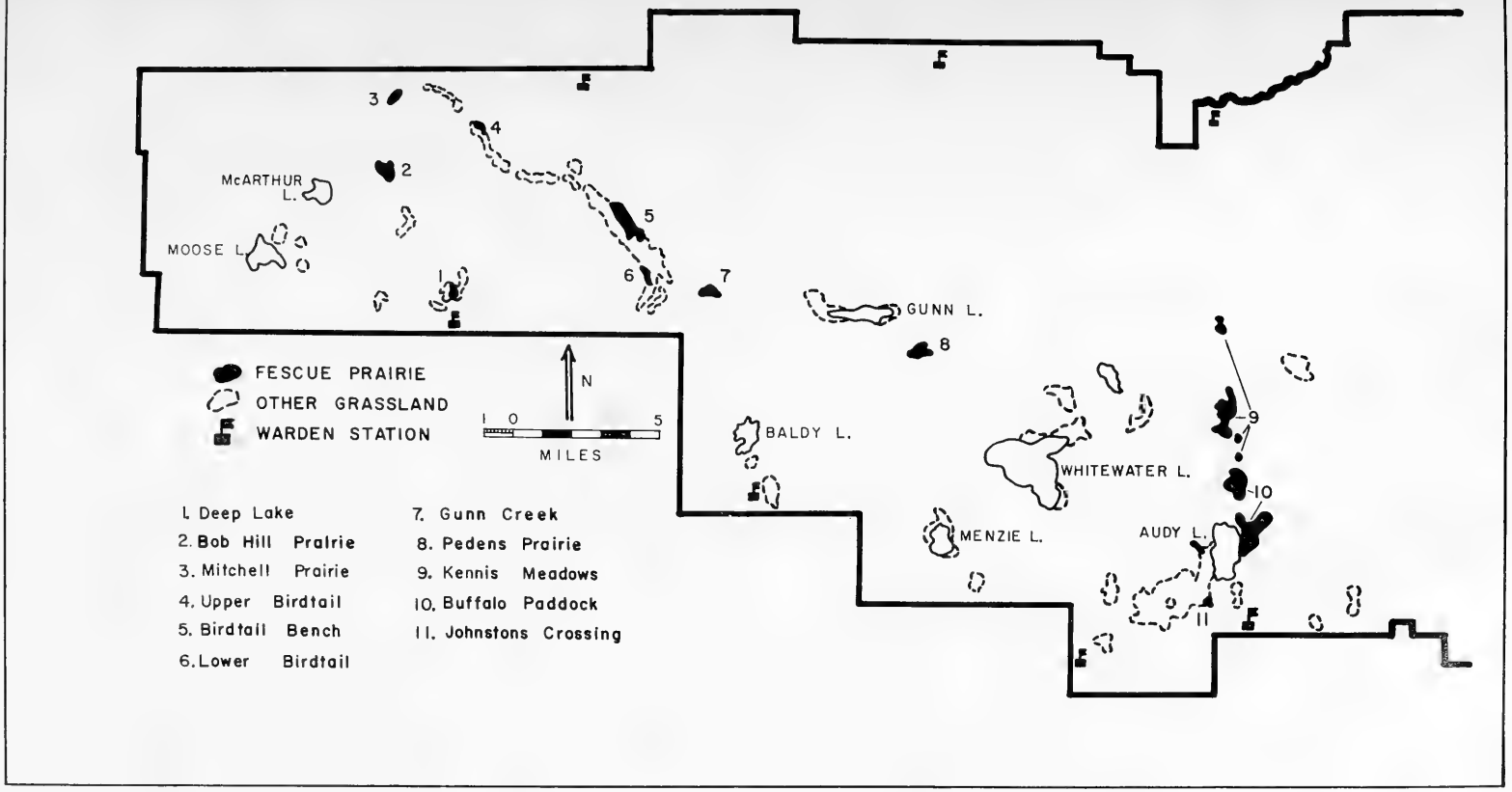

FIGURE 1. Map of Riding Mountain National Park, Manitoba, west of Range 19, showing distribution of fescue prairie.

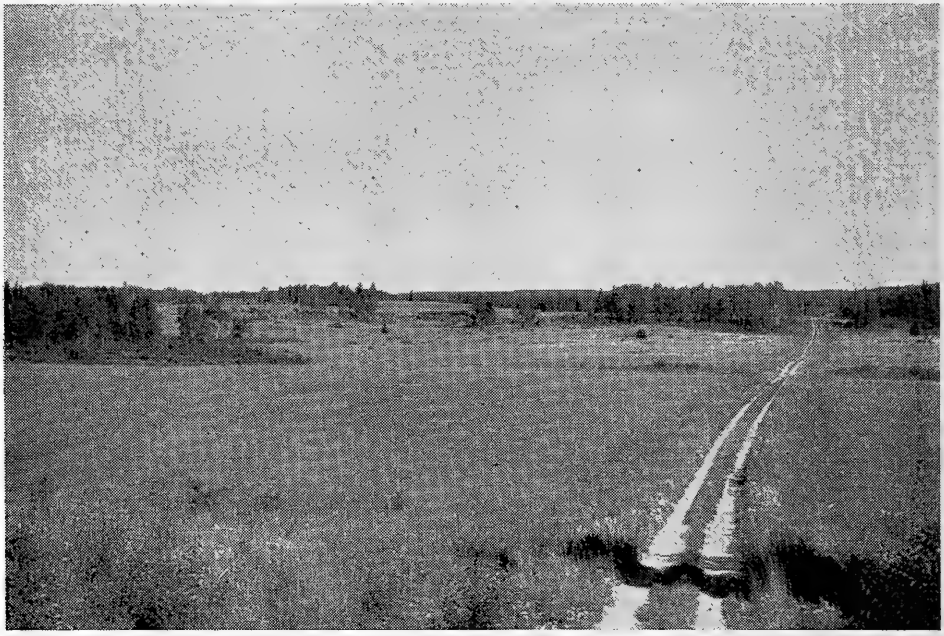

FIGURE 2. Bob Hill Prairie, a typical area of fescue grassland at Riding Mountain.

THE STUDY AREA

Riding Mountain National Park, an area of 1,148 square miles, occupies a plateau reaching 2400 feet in elevation, averaging about 2000 feet, located about 140 airline miles N.W. of Winnipeg. The northern and eastern slopes rise abruptly from the Manitoba plains, the southern slope rising more gradually. To the west the plateau merges almost imperceptibly with the general level of the Saskatchewan plain. The plateau itself varies from gently undulating to distinctly rugged with many hills and ridges.

The northern and eastern parts of the Park are heavily forested with both mixed and pure stands of white spruce (*Picea glauca*), jackpine (*Pinus banksiana*), aspen (*Populus tremuloides*), and balsam poplar (*Populus balsamifera*) — essentially a boreal association on grey-wooded soils. Black spruce (*Picea mariana*) and tamarack (*Larix laricina*) are common in areas of poor drainage, often in association with dwarf birch (*Betula glandulosa*) and Labrador tea (*Ledum groenlandicum*). The southwestern portion of the Park supports a parkland type of cover developed on black soils, the characteristic tree being aspen. All of the fescue prairie is located in this area.

Shrub growth throughout the Park is both dense and diverse. Willows (*Salix* spp.) form dense stands in wet open areas, while hazel (*Corylus cornuta*) is the dominant shrub of the aspen understory. Other abundant shrubs on upland sites are rose (*Rosa acicularis*), pincherry (*Prunus pensylvanica*), chokecherry (*P. virginiana*), serviceberry (*Amelanchier alnifolia*), red-osier dogwood (*Cornus stolonifera*) and snowberry (*Symphoricarpos albus*).

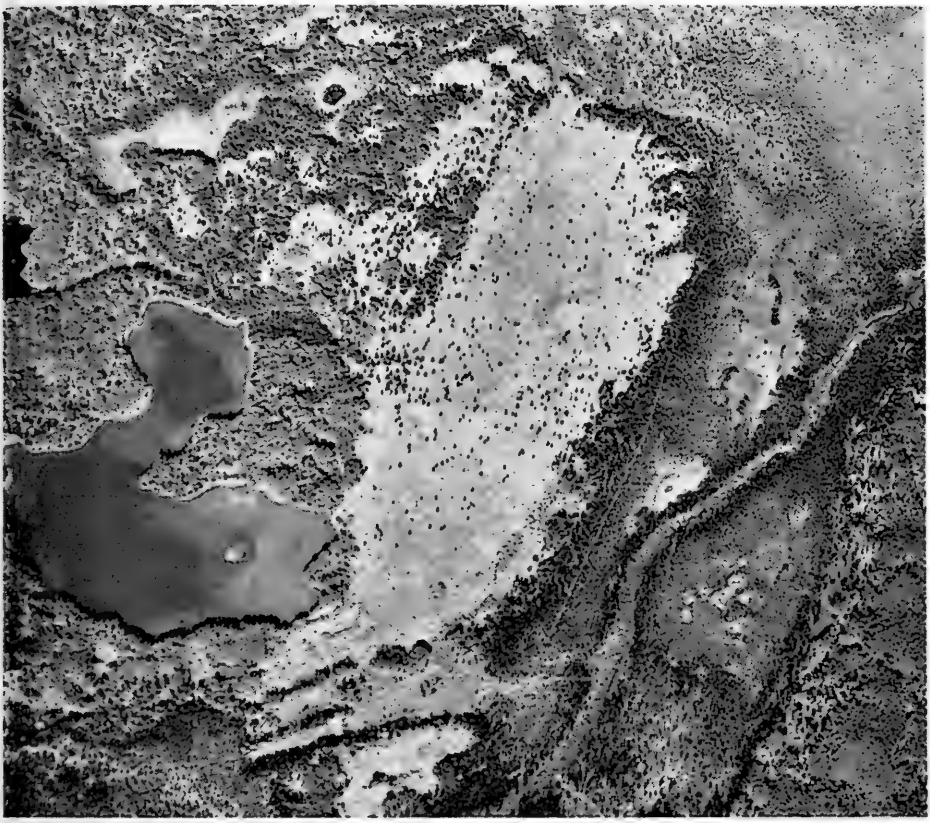

FIGURE 3. Mitchell Prairie and dense forest of aspen and white spruce surrounding it. This was the only fescue grassland noted which had spruce trees scattered over it.

METHODS

Examples of "typical" fescue prairie were examined at four widely spaced sites: Bob Hill Prairie, Birdtail Bench, Gunn Creek, Kennis Meadows (Figure 1). The sites have had a negligible amount of grazing by domestic cattle in recent years, but are grazed regularly, though not heavily, by elk (*Cervus canadensis*).

At each site four circular plots, 9.6 sq. ft. in area, were mechanically located 100 feet east, west, north, and south of a stake driven into the ground at a place considered to be typical. The vegetation on each plot was clipped, separated by species into paper sacks and weighed green using an 18 oz. capacity spring scale graduated to .2 oz. Care was taken not to include residual growth of the previous year which was often abundant. Production of shrubs included only leaves and twig growth of the year. All sampling was done from July 16 to 24, 1963. Control samples of the major species present were collected and dried at room temperature and humidity so that factors for conversion of green to air-dried weight could be determined. For the few minor species average conversion factors for grasses and for forbs were used.

Botanical nomenclature is that used by Scoggan (1957) with the exception of rough fescue, herein considered to be *Festuca scabrella* Torr. rather than *Festuca altaica* trin. var. *major* (Vasey) Gleason.

THE *Festuca scabrella* ASSOCIATION

The known areas of fescue prairie in the western portion of Riding Mountain National Park are indicated in Figure 1. Their total acreage is not great, nevertheless, they are distinctive in botanical composition and well differentiated from surrounding communities (Figures 2 and 3). Most are from 80 to 300 acres in size and widely scattered. All occur between 1800 and 2100 feet above sea level on quite level terrain.

Fescue prairie was probably more extensive and widely distributed in this area in the past but has been invaded by aspen and white spruce forest, resulting in the few relict areas presently existing. This opinion is consistent with the suggestion of Campbell et al. (1962) that, in Alberta and Saskatchewan, the aspen parkland developed largely in fescue prairie. The occurrence of fescue prairie in the Riding Mountain area can likely be attributed to greater moisture availability than in the mixed prairie to the southwest, owing to lower temperatures and slightly higher precipitation. The slight elevational increase of the plateau above the surrounding plains appears to result in increased rainfall although exact data are lacking. The requirement of fescue prairie of an average annual precipitation in excess of 15 inches (Campbell et al. 1962) appears to be satisfied in this area.

Cattle grazing in the southwestern regions of the Park, prevailing since before it was established as a National Park in 1930, has greatly complicated the recognition of the former extent of the *Festuca scabrella* association. Some heavily grazed grassland areas which now support little but bluegrasses (*Poa* spp.), dandelion (*Taraxacum officinale*) and shrubby cinquefoil (*Potentilla fruticosa*), are physiographically similar to, and merge gradually with, adjacent areas grazed to a lesser extent or not at all and dominated by *F. scabrella.* Such a situation occurs in the valley of Birdtail Creek. In one area wild oatgrass (*Danthonia intermedia*) was abundant in the transition zone between tracts dominated by *Poa* and *Festuca.*

Species composition of fescue prairie at Riding Mountain is indicated in Table 2. As in Alberta and Saskatchewan, this community is easily recognized since the dominant species is a very vigorous and conspicuous plant and is not an important component of any other community. The foliage of rough fescue frequently reaches 16 inches and the culms 26-30 inches in height. During the three years of range management studies in the Park (1961, 1962, 1963) flowering culms were produced only in 1963, but then very abundantly. Seed heads were also numerous on rough fescue in North Dakota in 1963 but had been uncommon in the four preceding years (Cosby 1964).

Some comparisons of fescue prairie composition at Riding Mountain with that in Saskatchewan (Coupland and Brayshaw 1953) are made in Table 3. In comparing these data a number of factors should be kept in mind. The results of Coupland and Brayshaw are expressed as percentage cover composition based on point transect data, whereas my percentages are based on the dry-

TABLE 1. — Species composition and productivity of the *Festuca scabrella* association in Riding Mountain National Park

Species	Pounds per acre (dry matter)	Per cent of forage class	Frequency in 16 plots
Festuca scabrella	707.9	71.9	16
F. ovina var. *saximontana*	7.9	0.8	4
Stipa spartea var. *curtiseta* / *S. richardsonii*	141.8	14.4	12
Agropyron trachycaulum / *A. smithii*	36.4	3.7	8
Bromus inermis	9.8	1.0	4
Koeleria cristata	41.3	4.2	13
Other grasses*	7.9	0.8	–
Carex spp.	31.5	3.2	7
TOTAL GRASS AND SEDGE	984.5	100.0	
Cerastium arvense	15.6	3.2	5
Thalictrum occidentale	18.9	3.9	14
Fragaria glauca	12.6	2.6	11
Geum triflorum	6.3	1.3	1
Potentilla arguta	17.9	3.7	10
Vicia americana	12.1	2.5	13
Polygala senega	9.9	2.0	6
Lithospermum canescens	12.0	2.5	8
Monarda fistulosa	14.4	3.0	10
Galium boreale	21.7	4.5	13
Campanula rotundifolia	7.4	1.5	10
Agoseris glauca	10.5	2.2	5
Achillea lanulosa	58.3	12.1	15
Artemisia gnaphalodes	7.1	1.5	6
Aster laevis	31.6	6.5	14
Aster spp.	89.0	18.4	
Erigeron spp.	8.9	1.8	8
Solidago missouriensis	46.9	9.7	13
S. rigida	54.6	11.3	
Other forbs*	27.9	5.8	–
TOTAL FORBS	483.6	100.0	
Amelanchier alnifolia	12.4	7.3	3
Rosa acicularis	7.3	4.3	5
Arctostaphylos uva-ursi	140.1	82.7	5
Other shrubs*	9.7	5.7	–
TOTAL SHRUBS	169.5	100.0	
GRAND TOTAL	1,637.6		

*Those species contributing less than five pounds of dried matter per acre (listed below).
Grasses: *Poa pratensis, Danthonia intermedia, Agrostis scabra.*
Forbs: *Smilacina stellata, Stellaria longipes, Comandra pallida, Anemone canadensis, Heuchera richardsonii, Lathyrus venosus, Viola* sp., *Zizia aptera, Agastache anthiodora, Liatris ligulistylis, Taraxacum officionale*
Shrubs: *Potentilla fruticosa, Prunus virginiana, Symphoricarpos albus*

weight contribution of each species. Also, the Saskatchewan data were collected primarily in 1944 and 1950, while my work was done in 1963 and variations in weather during the intervening period could have altered botanical composition. It is also possible that different workers might have selected somewhat different sites as "typical" of the association at Riding Mountain, i.e. perhaps areas with less forb and shrub cover than those I selected. Despite such limitations it is felt that the percentages in Tables 1 and 2 represent fairly closely the relative importance of the subdominant grasses and sedges to one another and to *Festuca scabrella*, as well as the relative contribution of the graminoid, forb and shrub fractions to total forage production.

Coupland and Brayshaw (1953) noted that in the aspen grove region, the importance of *Festuca scabrella* varied from complete dominance in the northern fringe to a position of codominance with *Stipa spartea* var. *curtiseta* in the northern part of the dark brown soil zone. Throughout all of the black soil zone however, *Festuca* was much more abundant than *Stipa*, and such appears to be the case at Riding Mountain. Although *F. scabrella* comprised about 72% of the graminoid vegetation on fescue prairie at Riding Mountain, it made up only about 43% of the total vegetation because of the considerable contribution of forbs and, to a lesser extent, shrubs. In the two Saskatchewan areas (Table 2) *Festuca* made up a similar, fairly low percentage of total vegetation, but also made up a much lower percentage of graminoid vegetation than at Riding Mountain. This appears to be largely due to the much greater production of sedges in the Saskatchewan study areas. Needlegrasses (*Stipa* spp.) were the most important subdominant grasses at Riding Mountain. Both *S. spartea* and *S. richardsonii* were encountered but were lumped during weight determinations, therefore, the relative contribution of each to forage production is not known. Coupland and Brayshaw (1953) found *S. spartea* to be the most important subdominant grass in fescue prairie west of Saskatoon, although that species was of minor importance on the benchlands of the Cypress Hills. Evidently *S. spartea* is more abundant on the higher slopes of the Cypress Hills (Coupland, 1961).

Forb growth appeared to be much greater in fescue prairie at Riding Mountain than in the other two areas. This apparent difference may be due partly to the different sampling techniques used. The point sampling technique probably underestimates the actual production of non-graminoid herbs, nevertheless the differences in forb production cannot be attributed entirely to this factor. The years 1962 and 1963 had higher than average precipitation in the Riding Mountain region and this may have contributed somewhat to the luxuriance of forb growth. Most abundant forbs in the Cypress Hills were *Cerastium arvense*, *Achillea millefolium* and *Galium boreale*, and west of Saskatoon were *Solidago glaberrima*, *Artemisia frigida*, *Anemone patens*, *Antennaria microphylla*, *Phlox hoodii* and *Cerastium arvense* in that order (Coupland and Brayshaw 1953). At Riding Mountain, asters, principally *A. laevis*, were the most abundant forbs. Forbs of the composite genera *Aster* and *Solidago* made up about 46% of total forb production. *Achillea* sp. and *Galium boreale* were also fairly abundant. A number of other species (Table 1) were of frequent

TABLE 2. — Composition of fescue prairie at three sites in the Canadian Prairies

	% of graminoid vegetation			% of total vegetation		
	Cypress Hills*	West of Saskatoon*	Riding Mountain	Cypress Hills*	West of Saskatoon*	Riding Mountain
Festuca	59.0	35.4	71.9	44.1	32.2	43.2
Stipa	2.2	13.0	14.4	1.6	11.9	8.7
Agropyron	5.9	3.5	3.7	4.4	3.2	2.2
Koeleria	7.1	9.8	4.2	5.3	8.9	2.5
Other grasses		11.1	2.6		10.1	1.6
Carex	25.8	27.2	3.2	19.3	24.8	1.9
TOTAL GRASS-SEDGE				74.7	91.1	60.1
Forbs				5.4	8.4	29.6
Shrubs				19.9	0.5	10.3
GRAND TOTAL				100.0	100.0	100.0

*Data from Coupland and Brayshaw (1953).

occurrence in the areas sampled, but contributed little to total forage production.

In the two Saskatchewan study areas Coupland and Brayshaw (1953) found shrubs abundant only in the Cypress Hills, where one species, shrubby cinquefoil (*Potentilla fruticosa*), made up 98% of shrub cover or 19.5% of total cover. The only other shrub noted there was Rose (*Rosa* sp.). Shrubs made up about 10% of fescue prairie production at Riding Mountain, but occurred in only a small number of the sample plots. *P. fruticosa* was of minor importance there, but appears to increase considerably with grazing pressure. The buffalo paddock in the Park appears originally to have been established on fescue prairie and remnants of that association still occur there. Since 1931 it has been grazed moderately to heavily by up to 62 head of buffalo (*Bison bison*) and now has an abundance of shrubby cinquefoil. About 83% of shrub growth on the plots clipped at Riding Mountain was bearberry (*Arctostaphylos uva-ursi*), but that species occurred in only a small number of plots. I presently feel that the areas sampled were not all "typical" fescue prairie with regard to the occurrence of that species. If each plot location had been selected as a typical one, rather than being located mechanically once a general site was chosen (4 plots were clipped at each site), then areas where *Arctostaphylos* was abundant due to localized edaphic conditions would probably have been avoided. Shrubs other than *Arctostaphylos* made up only about 2% of the forage produced.

Campbell et al. (1962) estimated mean annual yield at two fescue prairie sites on the Canadian Prairies (location not stated) as 1,080 and 660 pounds of dry matter per acre. These values are considerably lower than the 1638 pounds at Riding Mountain in 1963. Probably the locations they sampled were nearer

the mixed prairie-fescue prairie transition, with associated lower precipitation and soil moisture efficiency.

SUMMARY

Small areas of fescue prairie occur, apparently as relicts, in the southwestern portion of Riding Mountain National Park. Vegetation on 16 sample plots was clipped and weighed by species in July, 1963. *Festuca scabrella*, made up about 43 per cent of the total, and about 72% of the graminoid vegetation. The most important subdominant grasses were *Stipa* spp.. Forbs and shrubs made up about 30 and 10 per cent respectively of total vegetation.

Compared with data for two Saskatchewan sites, a greater proportion of *Festuca* in the graminoid component and a greater proportion of forbs in the total vegetation is indicated. Many areas of natural grassland in the Park appear to have degenerated from an original fescue prairie association to a bluegrass-dandelion-shrubby cinquefoil association due to heavy grazing by domestic stock.

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THE PRAIRIE CHICKEN IN SOUTHWESTERN ONTARIO

HARRY G. LUMSDEN
Research Branch, Ontario Department of Lands and Forests, Maple, Ontario.

INTRODUCTION

FROM EARLY DESCRIPTIONS of the countryside in southwestern Ontario we know that suitable range for Prairie Chickens *Tympanuchus cupido americanus* existed there prior to and during the first days of European settlement. While the birds were reported early in pioneer days, it is not clear if they were present in pre-Columbian times.

Throughout their range Prairie Chickens have been sensitive to man's use of the land. Both in southwestern Ontario and on the prairies it was the development of pioneer farming which permitted their spread far from their original long-grass prairie range into habitats that were markedly different. It was the intensification of agriculture and the disappearance of areas of permanent grass that caused their decline. Hamerstrom, Mattson, and Hamerstrom (1957) have presented an interesting historical review of the spread and decline of the species and have discussed the relationship of Prairie Chicken abundance to grassland in all States and Provinces where the species has occurred.

This account summarizes much of the available information on the extent of the prairies in southwestern Ontario prior to intensive cultivation and settlement and gives a history of the spread and decline of Prairie Chickens in that area.

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DISTRIBUTION IN AREAS ADJACENT TO ONTARIO

The probable distribution of Prairie Chickens south of Lake Erie in Ohio was plotted by Leopold (1931). His map suggests that the original eastern boundary of their range lay approximately on the same latitude as Elgin County, Ontario and that thousands of square miles of their range in Ohio lay to the east of Essex County, Ontario. He did not indicate the northern limits of Prairie Chicken distribution in Michigan. Ammann (1957) thought

it quite possible that Prairie Chickens could have occurred on the natural prairies of southern Michigan. He quotes Watkins (1901) who stated that, "The prairie hen was found in great abundance by the first settlers of Michigan, inhabiting the marshes and patches of prairie land and among the more open hills upon which the scattered wide spreading oak tree grow."

PRAIRIE CONDITIONS IN SOUTHWESTERN ONTARIO

Transeau (1935) has discussed climate and the extension of prairie plant communities to the east in the area south of the Great Lakes. While he does not discuss conditions in Ontario he deals with the occurrence of a distinctive prairie flora and isolated prairie communities as far east as northwestern Pennsylvania and as far north as central Wisconsin and Michigan.

He has made the point that these prairie areas are not transition grasslands since the prairie-forest relationship was that of a mosaic of prairie and forest communities and the only transition was the forest border, at most, a few rods wide. Evidence that the prairie peninsula extended north of Lake Erie into Ontario is available from three sources; from the condition of some of the soil types, from zoogeographic and phytogeographic evidence and from the reports of early travellers.

Mr. G. A. Hills of the Research Branch, Ontario Department of Lands and Forests has pointed out to me that in the five counties of Middlesex, Elgin, Lambton, Kent and Essex, certain soil features exist which are not found as extensively elsewhere in Ontario east of the Great Lakes. In these counties there are areas in which the soils exhibit features which resemble those of prairie soils. For example, the depth and accumulation of organic matter in the A_1 horizon indicated that a low prairie flora rather than forest cover was the dominant vegetation over a long period of time.

This condition prevails over a large proportion of those areas mapped as Clyde clay, Clyde silt loam, Clyde loam, Tuscola fine sandy loam, Colwood fine sandy loam and Thames clay loam. The distribution of these soil types is shown in Figure 1, type (a).

Similar characteristics may be found locally in areas mapped as Brookstone clay and its stony phase, Brookstone clay loam and its sand spot phase, Brookstone loam, Brookstone silt loam, Toledo clay, and Toledo silt loam. The distribution of these soils is mapped in Figure 1, type (b). The local predominance of prairie flora communities on these sites was probably intermittent and of shorter duration than on the soil types mapped in (a).

Undoubtedly the extent of these southern Ontario prairies, particularly those located on soils in category (b), varied with fluctuations in climate. There were almost certainly periods following the retreat of the glaciers when the grasslands were far more extensive than they were in the period when the first Europeans appeared on the scene.

Schmidt (1938) presents zoogeographic evidence which supports the existence of an ancient steppe peninsula extending eastward between the Ohio River and the Great Lakes to western New York and Pennsylvania, perhaps with a further extension as a steppe corridor through the Mohawk Valley to southern New England and New Jersey. He mentions that the

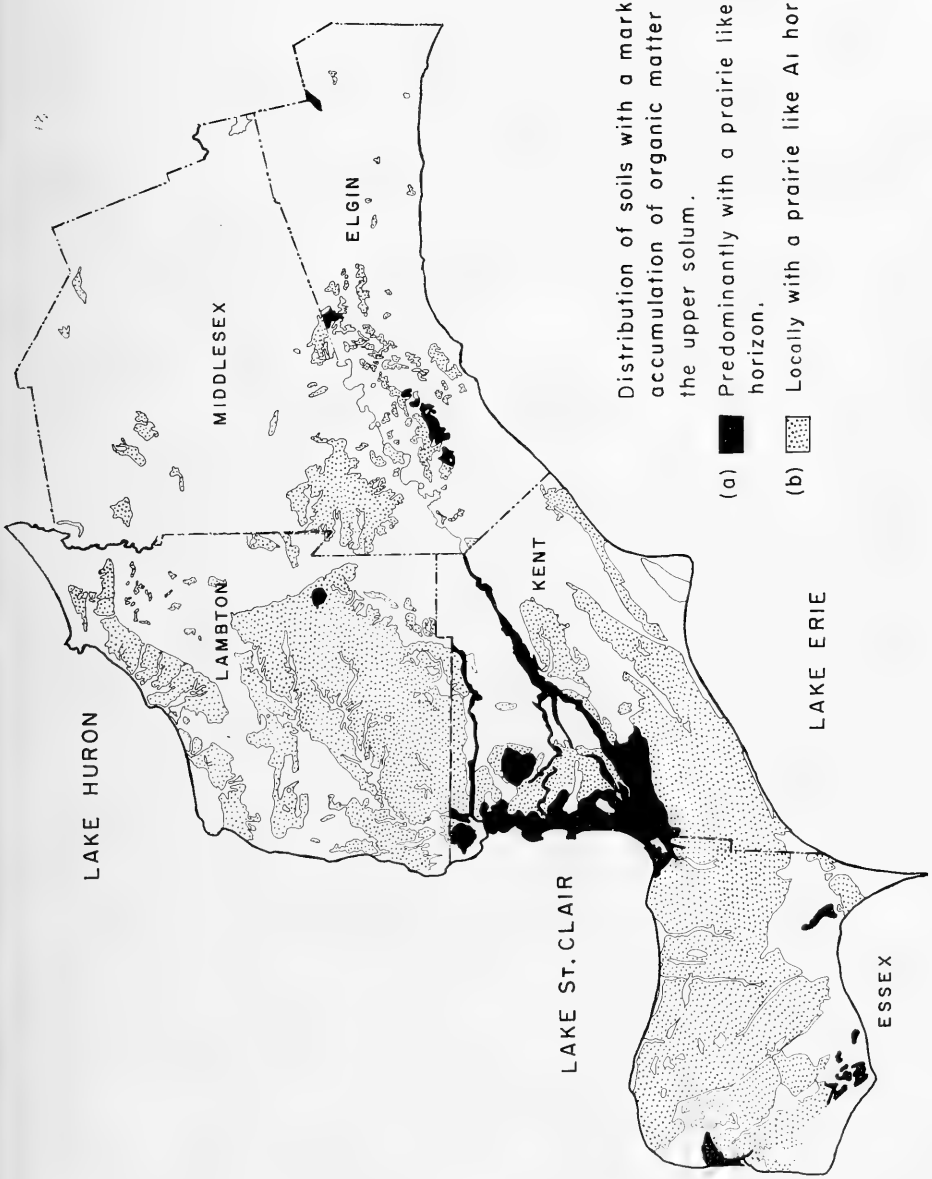

FIGURE 1. Distribution of soils with a marked accumulation of organic matter in the upper solum.

extinct population of the Heath Hen *Tympanuchus cupido cupido* of the Atlantic coast was possibly derived from an eastward range extension of the Prairie Chicken at an early time. The ranges of many of the reptile and amphibian species that he gives as examples in support of his arguments include southwestern Ontario.[1]

Palaeoclimatic data have been assembled by Dorf (1960) who has pointed out that, on the basis of the pollen record, there was a period of somewhat higher temperatures than prevail today which lasted from 5000 to about 2000 B.C. It was followed by a cooler condition which lasted until about 500 B.C. Thomas (*in* Urquhart, 1957) points out that this was a dry period during which drought resistant vegetation moved into Ontario from the southwest. We can expect that at this time the grasslands expanded their range. Dorf (*op. cit.*) suggests that a period of rising temperatures followed which reached a maximum between 1000 and 1300 A.D. This in turn was followed by a further period of climatic cooling.

Thomas (*op. cit.*) has analyzed southern Ontario weather records and has shown that the climate has become warmer and drier during the last 100 years.

It is probable that climatic conditions for the maintenance of prairie were not as favourable during the first years of settlement as they had been in earlier periods. There were, however, other powerful influences at work on the vegetation which would certainly have affected range suitability for Prairie Chickens.

INDIAN LAND USE

Prior to European settlement, various Indian tribes occupied southwestern Ontario. They practised agriculture but since they lacked any but the most primitive tools they were forced to cultivate only the lightest soils.

To judge the extent of Indian impact on the land, it is necessary to have some idea of their numbers and the duration of their influence. This can be obtained from two sources: from archaeological evidence and the reports of the first missionaries and voyageurs.

The recovery of arrowheads of Laurentian age throughout southwestern Ontario indicates that occupation has been continuous since nomadic family parties of food-gathering Indians occupied the area a short time after the retreat of the glaciers.

Lee (1952) has pointed out that a clear and unbroken sequence of cultural development in Ontario can be recognized extending from early Owasco to historic Neutral, a period of about 1000 years. There is evidence during this period of a dense human population with some groups living in palisaded villages.

The Indian population was evidently still dense during the first half of the Seventeenth century. The Missionary Segard (*in* Day, 1953), writing of his travels in 1632 among the Tobacco Nation which lived along the shore of Lake Huron and Georgian Bay, stated that when travelling from village to

[1]*Editor's note*: This statement remains valid despite the well-founded objections of Bleakney (1958. *A Zoogeographical Study of the Amphibians and Reptiles of Eastern Canada*... National Museum of Canada Bulletin 155; *see* p. 52) to the inclusion by Schmidt of *Emydoidea blandingi* and *Chrysemys picta marginata* with those forms whose distribution correlates with the prairie peninsula.

village he lost his way in the corn fields more often than in the woods. Brebeuf (*in* Coyne, 1895) estimated the Hurons to exceed 30,000 in number and describes the Neutrals in 1634 to be much more numerous. In 1641 the Jesuit Relations estimated at least 12,000 Neutrals after decimation by a three year smallpox epidemic.

Fire in the hands of the Indian was a powerful tool in maintaining and extending the openings in the forest. Day (*op. cit.*) has brought together much interesting information on this subject relating to New England, New York, and New Jersey. It is likely that the extinct Heath Hen owed much of its range and even possibly its very existence within historic times to the unbridled use of fire by the Indians.

Most of the information on burning by Indians presented by Day is applicable to southwestern Ontario. The demand for firewood in populous villages must have been considerable and Day quotes Loskeel (1794) on the prodigal use of fuelwood by the Iroquois.

The use of fire for clearing agricultural land must have been the most effective tool of a people still living close to the stone age. Soil depletion in the absence of fertilization forced a shifting form of cultivation and very extensive areas must have felt the weight of the Indian hand.

Thus we can visualize a country supporting large Indian populations who practised a shifting form of cultivation and whose unrestricted use of fire constantly kept the forest back from their villages and in an open or semi-open condition. We can conclude that in addition to the natural prairies there probably was extensive range created by the Indians which was suitable for occupation by Prairie Chickens.

A marked change took place in land used by the Indians during the second half of the Seventeenth century. According to Morris(1943) in 1648 the Iroquois living in the area now known as New York State made war on the Huron Indians. After dispersing them, they turned on the Neutrals who claimed the country between Niagara and Detroit and between 1650 and 1651 utterly destroyed them as a nation and de-populated the countryside.

The Iroquois did not settle on the lands they had conquered, the Indian influence on the vegetation therefore was greatly reduced. Over the following 150 years many Indian clearings gradually filled in with scrub and then forest. Site conditions, however, would have prevented the establishment of forest on the natural prairies.

EARLY WRITTEN ACCOUNTS OF THE LAND AND ITS WILDLIFE

In 1679, Father Louis Hennepin, who accompanied La Salle on his voyage in the Griffon wrote (*in* Thwaites, 1903) the following description of the country along the Detroit and St. Clair Rivers: "The 11th (August) we went further into the streight and passed between two small islands which made one of the finest prospects in the world. This streight is finer than that of Niagara being thirty leagues long and everywhere one league broad, except in the middle, which is wider, forming a lake we have called St. Clair. The navigation is easy on both sides, the coast being low and even. It runs directly from north to south. The country between those two lakes is very well

situated, and the soil very fertile. The banks of the streight are vast meadows, and the prospect is terminated with some hills covered with vineyards, trees bearing good fruit, groves, and forests, so well disposed than one would think nature alone could not have made, without the help of art, so charming a prospect. That country is stocked with stags, wild goats, and bears, which are good for food, and not fierce as in other countries; some think they are better than our pork. Turkey cocks and swans are there also very common; and our men brought several other beasts and birds, whose names are unknown to us, but they are extraordinary relishing."

This passage probably contains one of the first references to the presence of swans in Ontario and it is likely that they were a summering population of Trumpeter Swans *Cygnus buccinator*. His "wild goats", as noted by the editor of his papers, were probably White-tailed Deer *Odocoileus virginianus* and the stags were probably Elk *Cervus canadensis*, the smaller relative of which he probably knew in his native Holland. This was the first area in Ontario from which Prairie Chickens were reported over 150 years later. One can only speculate on the identity of his "extraordinary relishing" birds whose name he did not know.

In a description of the country around the Detroit settlement M. de Lamothe Cadillac, the Commandant, wrote in 1701 (*in* Lajeunesse, 1960) about ". . . . .. the golden pheasant, the quail, the partridge, the woodcock, the teeming turtle dove swarm in the woods and cover the open country intersected and broken by groves of full grown forest trees . . . . .". He also mentions Wild Turkeys, Bison, Swans, Geese, Duck, Teal, and Bustard.

What was the identity of his "golden pheasant"? Was this one of the species that "covered the open country"? I think it likely that he referred to the Prairie Chicken since he accounts for Quail *Colinus virginianus* and Ruffed Grouse *Bonasa umbellus*, the other most likely contenders for this name.

Under French auspices the Detroit settlement was developed on both sides of the river. It was taken over by British forces in 1760, before final surrender of the west portion to the United States. In 1776 Lieut. Governor Hamilton was writing to the Earl of Dartmouth about the "very extensive prairies in the settlement", and the Rev. J. F. Hubert also mentions them in a letter to General Haldimand in 1781 (both in Lajeunesse, 1960).

In 1790 a treaty signed with the Iroquois, who then claimed the north shore of Lake Erie, opened this part of Ontario for settlement by Europeans. That year a surveyor, Patrick McNiff, started his work in parts of Essex and Kent Counties. His field notes (1790), dealing with the area lying between Point Pelee and the Detroit River, contain references to "excellent meadow land" and he notes (1793) that meadows were also present on Peach, Hog and Fighting Islands in the Detroit River. On Harsen's Island (now known as Herson Island on the Michigan side of the St. Clair flats) he reports that there were about 300 acres of land fit for culture, the rest being meadow or marsh, and Isle Channel Ecerte next east of Harsen's Island (now known as Squirrel Island on the Ontario side of the international border) was also mostly meadow or marsh. On the mainland east of the delta of the St. Clair River, he sur-

veyed the Baldoon settlement for Lord Selkirk reporting (*in* Mitchell, 1914) that it contained about 950 acres, the greater part of which consisted of prairie bordering the river, the balance to the north being wooded land indented on the south and west with prairie.

Lauriston (1952) using McNiff's notes described conditions along the lower Thames River in Kent County. "On each side and for a distance upstream of 6 miles were extensive meadows and marshes without any wood except for a few scattered trees. To the Dover side the marshes and meadows extended north northeast as far as the eye could see. To the south they were confined to much shorter limits[1] . . . Eight miles up, settlement on the south bank commenced. Thence to the forks[2] the land is very good on each side but on the south side in general up to near the forks, the woodland does not extend back from the Thames more than thirty acres, in many places not so far; then commences a plain and marsh. On the north side the plain and marsh do not come so near the river." The surveyor Iredell (1796) in his notes, also mentions the plains in Raleigh and Dover Townships.

It was not until after the war of 1812 that extensive clearing was done in the western Lake Erie, Lake St. Clair, and Lake Huron region. This was considerably later than the settlement which had taken place in Ohio and southeastern Michigan. Once again the forest was pushed back but by a people less dependent on fire and equipped with metal tools. They found many completely open areas and much land that required but little effort to clear.

In an anonymous publication (1832) written for the guidance of immigrants, probably written by Dr. William Dunlop who was founder of Goderich (C. H. D. Clarke, *pers. com.*), appears the following passage: "Every here and there you have have an immense prairie furnishing pasture for more cattle than are likely to graze on them for a century to come". These prairies were "at the extreme west of the province" of Upper Canada. He also states: "Grouse are found on the plains of the western district. They are like the European grouse but smaller. I have never eaten any of them so I cannot say anything as to their flavour but they make good sport."

The comparison with "European grouse" is probably with the Black Grouse *Lyrurus tetrix* the female of which is similar in color but slightly larger than a Prairie Chicken. His reference is not likely to be to the Red Grouse *Lagopus lagopus scoticus* because this species is much smaller than a Prairie Chicken and is quite different in color.

Jameson (1837) wrote: "Lake St. Clair into which the Thames discharges itself is between Lake Erie and Lake Huron; the banks are formed of extensive prairies of exhaustless fertility where thousands of cattle might roam and feed at will." The soils of this area, as indicated in Figure 1, have the characteristics of prairyerths. Today there is even a village situated on the south bank of the Thames called Prairie Siding. Nothing now remains of the original prairie, part of the flattest land is now intersected with dredge cuts and all has been turned into rich farm land.

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[1]Four to six miles is the distance given in McNiff's manuscript.
[2]Where Chatham now stands 15 miles from the mouth of the Thames.

PRAIRIE CHICKEN RECORDS IN SOUTHWESTERN ONTARIO

The first unequivocal account of the occurrence of Prairie Chickens in Ontario is probably that of Charles Fothergill who emigrated from Britain to Toronto and lived there until his death in 1840. The quality of his ornithological work was high and his observations are considered to be accurate (*see* Baillie, 1944). He has this to say about Prairie Chickens (Fothergill, *unpubl.*): "In talking with Mr. Wilkinson M.P. he tells me that they have a grouse in the west in the neighbourhood of Sandwich* tho not very common, larger and entirely different from the bird called the Spruce Partridge. He describes it as being of the most exquisite flavour. It is confined to the plains and goes mostly in pairs. 'Tis said to have been introduced some years ago from England. It has spread more across the river in the Michigan territory and towards the banks of the Miami than in Canada. He says it is totally different from the Spruce Partridge which is said never to be good for the table and is little more than half the size." Although not specifically dated, this passage was probably written about 1828 for on the opposite page there is a note on the Ruffed Grouse dated October 16 of that year.

All the localities from which Prairie Chickens have been reported are indicated in Figure 2.

The next mention of Prairie Chickens in Essex County is contained in a letter quoted by McIlwraith (1894) which was received from Mr. W. E. Wagstaff, "one of the oldest and most respected settlers in the County of Essex." Mr. Wagstaff wrote: "I have never seen prairie chickens alive, but have heard of their being seen in bands about Sandwich. When I first came to Amhurstburg about 1840, I heard the old sports tell of having killed them in the gardens of the town."

The earliest Ontario specimens that are still preserved are probably a male and female from the collection of the Hon. G. W. Allen, which is now in the Royal Ontario Museum of Zoology and Palaeontology. These specimens are labelled Essex County, 1846. There are two other specimens from the same collection but they lack data.

The first mention of Prairie Chickens on the prairies near the mouth of the Thames, described by Jameson, appears in the 1850's.

Edwin Sandys says in a book he co-authored with T. S. Van Dyke (1902) that the first Prairie Chicken he ever heard booming . . . "was in western Ontario on what is known as Raleigh plains — an extensive tract of low marshy land lying for miles along the south bank of the Thames River." He was a boy at the time and succeeded in shooting a male while investigating the strange noise. He remarks: "Later developments proved the old male to have had company, to be exact, upon the plains in question, and upon another similar expanse a few miles away, there were years later as many as seventy-five or one hundred 'chickens'."

He did not mention the date of this incident but he does say that it occurred when "Spring shooting of geese, duck, and snipe was then both legal and

*Now part of the city of Windsor.

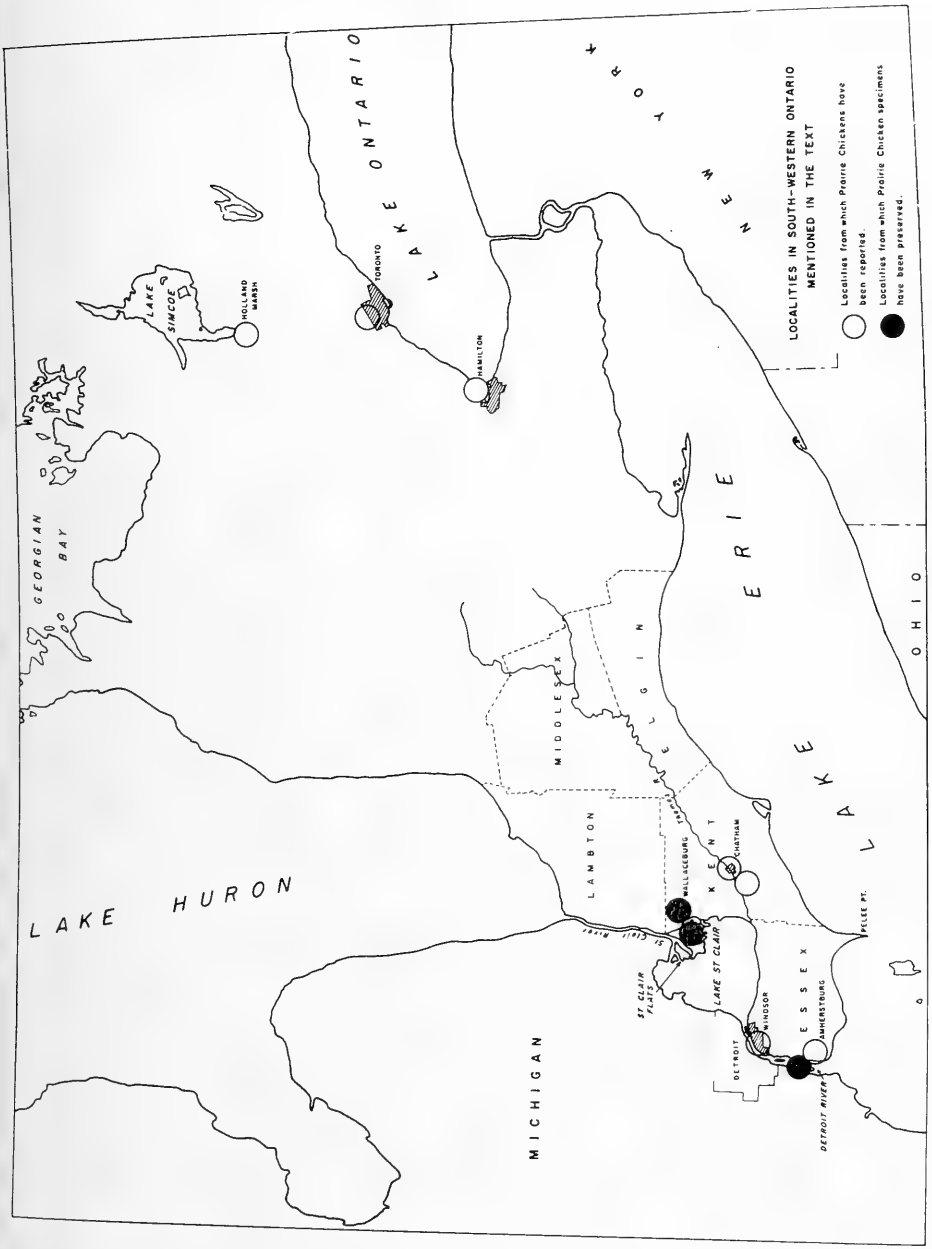

FIGURE 2. Localities in southwestern Ontario mentioned in the text.

amazingly good." Thus it must have been prior to 1856 when the first law restricting spring hunting of waterfowl in Upper Canada was passed.

Cottle (1859) includes *Tetrao cupido* in his list of birds adding in a footnote: "On the authority of an inn-keeper at Chatham who asserted that they were occasionally seen in the neighbourhood." This was probably not far from the locations mentioned by Sandys.

Evidence that Prairie Chickens spread as far as Toronto at an early date is provided by its inclusion in a list of birds contained in a Handbook of Toronto (1858). The species is marked with an asterisk which the author explains in a footnote that "Specimens of those so marked have been obtained in the immediate vicinity of Toronto."

It is probable that the bird had reached Hamilton by this time also but it was not until later that its presence was definitely recorded there. McIlwraith (*op. cit.*) mentions having seen a male in fine spring plumage shot in May, 1886, "between the bay and the lake near the canal at the beach." This was probably on Burlington Beach.

In November, 1887 he bought a male and female in the market at Hamilton which are now in the Royal Ontario Museum. While it is possible that these specimens had been shot in the vicinity of Hamilton, it is more likely that they had been imported from the west. There is a specimen in the collection of Mr. Hoyes Lloyd of Ottawa which was prepared by Mr. E. F. G. White. In answer to an inquiry about the origin of this bird, Mr. White in a personal communication wrote: "The bird that Mr. Lloyd has is an import, most likely from Chicago. Back in the eighties Bate and Co. of Ottawa used to sell game that he bought in Chicago. At the time we bought the grouse he had several wild turkeys, . . . At that time Lapointe — a fish and game dealer, used to import game from Europe or England, we got lapwing and one golden plover from him and quail . . . I have seen black cocks and red grouse in the shipments."

Holland Marsh was the northernmost locality reached by Prairie Chickens. J. P. Turner in a personal letter to Mr. J. L. Baillie dated July 17, 1932 wrote, "Many years ago my father shot some Prairie Chickens near Holland Marsh and I have heard of other early records." Baillie (1947) mentions two Prairie Chickens shot by John Turner while snipe shooting at the Holland River marsh about 1875. The last record for this area was a bird Edwin Sandys said he had flushed about 1889.

Towards the end of the nineteenth century we find that all references to Prairie Chickens in southern Ontario associate them with large marsh areas. The original prairies had long since come under the plough and the poorly drained low prairies were being speedily tiled for cultivation. Pioneer farming with the widespread use of fire as an aid to clearing had given way to a more intensive form of agriculture and little suitable range for Prairie Chickens remained except in and around poorly drained land.

One of the largest marshes in southern Ontario lies on the estuary of the St. Clair River in Kent County. Part of it extends across the border into Michigan. Morden and Saunders (1882) record Prairie Chickens from the St. Clair Flats in their list published in 1882. Also, a specimen from the "Flats"

and one labelled "Wallaceburg" were taken by Dr. H. J. Garnier in February and March of 1885.

Saunders (1910) was probably referring to these specimens when he wrote "The country around Chatham, and from there to Windsor, has much ground suited to the needs of this bird and there can be little doubt that it was once common through most of this territory, although the district ten miles north of Chatham is the only spot from which records have been preserved." He mentions two specimens which were not saved but were taken near Chatham about 1882 or 1883 and passed through the hands of Alex Gow.

The last specimen of a Prairie Chicken from southern Ontario, now in the Royal Ontario Museum, was preserved by Gow. It was a female shot on 29 April, 1897 on Fighting Island, a marshy island in the Detroit River, eight miles south of Windsor. By 1900 there may have been a few small isolated populations struggling to survive in the face of agricultural development. I can find evidence of only one group of birds which lasted into the twentieth century, significantly on an area where modern farming was introduced relatively late. The old Indians who live at the Walpole Island Indian Reserve, which includes the Ontario side of the St. Clair Flats, remember the species well and those of middle age remember their parents talking about Prairie Chickens. Their name for the bird was "Ke-wa-nee". It appears that some were still to be found as late as the 1920's for Mr. William Soney, now 88 years old, shot one on St. Annes Island "about 40 years ago". Mr. Silas Thomas now over 75 years old shot his last, "about 30 or 40 years ago", on the Hickory Ridge on Walpole Island. This area, according to Mr. Earl Sands, was a prairie with a few scattered thorn bushes. It lies adjacent to St. Annes Island. Mr. Bill Dodge and Mr. Clarence Sands both saw them for the last time on this prairie about 1923 or 1924.

CONCLUSIONS

At this late date incontrovertible evidence of Prairie Chicken occurrence in Ontario in pre-settlement days would have to come from archaeological investigations. It is unfortunate that, so far, few pre-contact Indian sites have been examined in the area in which Prairie Chickens might have occurred. Wintemberg (1939) does not record the species in the Lawson site in Middlesex County. Through the courtesy of Dr. K. E. Kidd, Curator, Department of Ethnology, Royal Ontario Museum, I was able to examine the bone material collected in the Krieger site, Harwich Township, Kent County. There were no Prairie Chicken bones in this collection.

Prairie Chickens were certainly present in Essex County in 1828. We can probably say that the bird did not reach the Toronto area in Fothergill's time. He gave such a good account of the birds of his home area that, had Prairie Chickens been present, he undoubtedly would have included them. Between the time of his death in 1840 and 1858 they must have reached Toronto. Shortly after this it is probable that the bird was occupying its greatest area and had reached its peak of abundance in southwestern Ontario.

The distribution of Prairie Chickens in the province at this time was probably discontinuous and the birds were only locally abundant. They were

probably never an important game bird and were hardly mentioned in the testimony on game presented to the Game and Fish Commission which reported to the Legislative Assembly in 1892.

After 1875 all records of the bird indicate that it was inhabiting marshes and we may conclude that it found its range on the farm lands deteriorating because of changes in agricultural practices. It is probable that by the 1880's there were only isolated colonies which disappeared one by one.

The last specimen to be preserved came from Sandwich West, in 1897, the township from which it was first reported in 1828. The bird apparently survived in this part of the province until about 1923 or 1924 on the Walpole Island Indian Reserve.

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SUMMER BIRDS WINTERING ON SOUTHERN VANCOUVER ISLAND

DAVID STIRLING

Parks Branch, Department of Recreation and Conservation, Victoria, B.C.

RECENT CHRISTMAS BIRD COUNTS have shown that well over 100 bird species can be found in winter on southern Vancouver Island, which for the purposes of this paper is that part south and east of Sooke Harbour, Finlayson Arm, and a line joining these two. In December 1961, 124 species were noted on count day and 14 others were seen during the week giving a total of 138 species. To obtain comparable counts elsewhere one must go to southern California, the Gulf Coast, and Florida. By comparison, the 1963 Audubon Society Christmas Bird Count showed Edmonton with 31 species, Toronto 72 species, and Halifax 52 species. Total individuals usually range between 45,000 and 50,000. Species contributing most to the grand total are gulls and waterfowl; robins and sometimes starlings are the most abundant of the passerines.

If we disregard all "expected" species and the usual observations of "unusual" species several forms usually regarded as summer visitors or migrants appear regularly and sometimes abundantly on Christmas counts. Cowan (1940) gives details of winter occurrence of ten species of summer birds during the ten years 1929 to 1938. He gives climatalogical data for the ten years 1887 to 1896 and the ten years 1929 to 1938 to support his postulation that increased occurrence of certain species is influenced by an amelioration of winter climate during the latter ten years. Although climatic changes could be an important reason for the increase in wintering records of summer birds, habitat modifications and thorough coverage of the area by bird-watchers in recent years appear to be factors which deserve recognition.

TABLE 1. — Number of observations (O) and total numbers seen (T) of sixteen wintering species. Asterisks indicate species mentioned by Cowan (1940). All observations are from December and January; most data are from Christmas counts.

Species	1958		1959		1960		1961		1962		1963		1964	
	O	T	O	T	O	T	O	T	O	T	O	T	O	T
*Band-tailed Pigeon	1	2	–	–	–	–	6	48	1	2	3	61	6	42
Mourning Dove		–	1	1	1	1	–	–	–	–	2	21	1	2
Rufous Hummingbird	–	–	1	1	1	1	1	1	–	–		–	–	–
*Lewis' Woodpecker	1	2	1	1	1	1	1	1	–	–	–	–	1	2
*Hermit Thrush	–	–	1	2	–	–	3	3	3	3	5	9	3	5
*Western Bluebird	–	–	1	55	2	26	5	48	4	?	–	–	6	59
Water Pipit	–	–	1	?	1	3	–	–	–	–	2	39	–	–
*Cedar Waxwing	–	–	2	505	2	100	2	121	1	32	5	259	9	406
Orange-crowned Warbler	–	–	–	–	–	–	1	1	1	1	1	1	1	1
*Audubon's Warbler	–	–	–	–	1	1	1	1	1	3	1	3	–	–
*Red-winged Blackbird	5	371	1	?	5	197	7	40	3	38	5	64	7	77
Brown-headed Cowbird	–	–	–	–	–	–	1	6	–	–	1	11	1	4
American Goldfinch	–	–	1	?	–	–	2	7	3	25	–	–	3	12
Savannah Sparrow	–	–	1	1	–	–	1	1	3	3	1	5	2	2
*White-crowned Sparrow	3	10	2	10	5	39	4	7	5	19	4	21	4	13
*Golden-crowned Sparrow	6	60	9	36	7	195	10	101	7	92	11	129	9	104

Changes in habitat due to the activities of man have increased the amount of food and cover available to certain species. Dense thickets of broom, *Cytisus scoparius* and blackberry, *Rubus* spp. along fences are favoured sheltering areas for White-crowned and Golden-crowned Sparrows that seek food on adjacent field verges. Cattle feeding lots and farm yards have wintering flocks of blackbirds and Starlings. Ornamental and commercial plantings of berry-bearing shrubs such as mountain ash, *Sorbus* spp, English hawthorn, *Crataegus oxyacantha*, and holly, *Ilex* sp. have added considerably to the food supply of Band-tailed Pigeons, Cedar Waxwings, and Robins. Sheltered gardens and bird feeders help Rufous Hummingbirds and warblers to survive through at least part of mild winters. Feeders are so popular now that they have become an important aid to wintering small passerines. White-crowned and Golden-crowned Sparrows, warblers, Hermit Thrushes, and a remarkable number of stragglers from east of the Rockies have been observed at feeders; passerine stragglers are seldom seen anywhere else, and they usually remain at the same feeder throughout the winter.

There are enough observers in the field now to make it unlikely that any species of bird will remain undetected for long. The limited extent and sharply defined boundaries of the Victoria area, and the fact that wintering species prefer to remain more or less sedentary help to insure that these birds will be quickly reported and kept under observation. The Victoria Christmas count is well organized and the compilers have tried hard to keep doubtful sightings off the records. An added check on sight records is the fact that most questionable species stay in the area for several weeks at least and therefore are seen well by several reliable observers.

I have compiled a table of winter records for the years 1958 to 1964 inclusive for nine of the ten species noted by Cowan. Winter records for an additional seven species which have been seen during this same period have been included. This table shows that most of these species have increased, some markedly since Cowan's notes of 1929 to 1938.

Only one species, the Lewis' Woodpecker, has shown a decrease. Cowan (1940) says "It is now an abundant breeding species." He cites records of one or two birds every winter for the years 1936 to 1939. In the winter of 1938-39 twelve to fourteen wintered in the oak groves of the Uplands. The Lewis' Woodpecker is no longer abundant on southern Vancouver Island. Only one or two breeding pairs were known during any summer from 1958 to 1961. Part of this declining population remained through the winter as the table shows. No breeding Lewis' Woodpeckers were found from 1962 to 1964. None wintered in 1962 or 1963. As there have been no records from other Island localities for several years it seems that the Vancouver Island population has disappeared. In early December, 1964, two were seen. These were possibly stragglers as they disappeared after a few days.

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VICTORIA NATURALIST 1958-65. Christmas Bird Count, 15:6; 16:6; 17:6; 18:6; 19:6; 20:6; 21:6.

Received for publication 16 May 1965

CORRECTION NOTE

In the paper "Some new or critical vascular plants of Alaska and Yukon" by A. E. Porsild which appeared in *The Canadian Field-Naturalist* 79(2), substitute for line 6 on page 80 the following correct line:

densely glandular with purplish black stalked glands", but in other respects it

THE SUPPOSED NESTING OF THE SLATY-BACKED GULL IN CANADA

W. Earl Godfrey
National Museum of Canada, Ottawa, Ontario

The only evidence of nesting on the North American continent of the palearctic Slaty-backed Gull, *Larus schistisagus*, was recorded by Bent (1921, p. 87). This is based on a specimen, adult male, bearing a label stating that it was taken from a nest on Harrowby Bay, northwestern Mackenzie, on June 9, 1901, by Captain H. H. Bodfish. The record is included in the breeding distribution of the species in the A.O.U. "Check-list of North American Birds" (Fifth edition, 1957).

A. M. Bailey (1948) questioned the record on the grounds that Harrowby Bay is far from the known breeding range of this gull. He examined the Harrowby Bay specimen (in the Museum of Comparative Zoology collection), considered it small for *schistisagus*, but did not refer it to any other species. E. O. Höhn (1958) spent the period July 18 to 23, 1955, on Harrowby Bay and made a careful but vain search for evidence of *schistisagus* there. However, in rejecting the Harrowby Bay record he made an unwarranted assumption that Bailey (1948) decisively established that the Harrowby Bay specimen is not a Slaty-backed Gull. Bailey did not establish that. In fact, it seems probable that the specimen really is a Slaty-backed Gull as it was originally so identified by no less an authority than Robert Ridgway. The writer has not examined it.

Captain Bodfish's data on the specimen label are all the evidence available. Captain Bodfish was a whaler and a remarkable man. He was not, however, an ornithologist although his broad interests included birds and he collected specimens of them. Due doubtless to lack of proper instruction, his methods of preparing bird specimen labels appear to have been faulty. This is shown in a letter in the files of the National Museum of Canada written by Louis B. Bishop on January 28, 1929, to P. A. Taverner, the appropriate parts of which are as follows:

"For weeks I have been trying to find a minute to write you on a subject on which I meant to talk with you in Charleston, but forgot every time we were together. That is that Paroquet Auklet in my collection, supposed to be from Franklin Bay, Arctic America.

"When I was in New Haven I read up in my catalogue all I had written about this lot of skins, found them all, and the original labels in the cases in which they were not attached to the skins, and attached them. As I wrote you I bought this lot from Babbitt of Taunton, and he wrote me all were collected by Captain Bodfish at Franklin Bay. All the skins had data, but these were written on slips of paper and slipped under the wing, and contained no

place. In at least one instance in a pair of birds in which the measurements were on the labels I found from measuring the birds that the labels had become transposed, the male slip of paper being under the wing of the female. All these slips of paper were the same, apparently torn from envelopes, except that of the Paroquet Auklet, and that was on different paper. And on going over these birds in my collection it came to my memory that I had always been a little doubtful if this bird had been collected with the others, or if Bodfish had taken it farther west, and sent it to Babbitt with the others. And I want you to have all the facts before you publish the record."

In his absorbing autobiography "Chasing the Bowhead", Bodfish (1936) tells us that on the voyage in question eastern Siberia was visited on the way north in June 1900; the winter of 1900-1901 was spent on Baillie Islands, near Harrowby Bay; and that the voyage ended in San Francisco on November 7, 1901.

In view of the known facts that Bodfish was in Siberian waters (although north of the known breeding range of the Slaty-backed Gull), that he had a habit of not attaching labels to specimens, and that he sometimes relied on memory for locality data, the chances for error in specimen data are great and, consequently, the Harrowby Bay record is quite unacceptable. There is, therefore, no valid record of the Slaty-backed Gull nesting on the North American continent and no valid record of any occurrence of the species in Canada.

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Received for publication 4 June 1965

REPORT OF COUNCIL TO THE EIGHTY-SEVENTH ANNUAL MEETING OF THE OTTAWA FIELD-NATURALISTS' CLUB

December 7, 1965

During the past year, five meetings of Council were held at the National Museum of Canada: December 17, 1964, March 18, June 3, October 19 and November 23, 1965. The average attendance was fourteen members. The Club's business was conducted in the usual orderly manner.
Appointments for 1965 were made as follows:

Editor, The Canadian Field-Naturalist	— F. R. Cook
Business Manager, The Canadian Field-Naturalist	— W. J. Cody
Chairman, Publications Committee	— D. D. Hogarth
Chairman, Excursions and Lectures Committee	— H. N. MacKenzie
Chairman, Reserve Fund Committee	— H. Lloyd
Chairman, Membership Committee	— F. H. Schultz
Chairman, Bird Census Committee	— G. H. McGee
Chairman, Macoun Field Club Committee	— H. Groh
Chairman, F.O.N. Affairs Committee	— R. Frith
Chairman, Public Relations Committee	— E. L. Leese
Chairman, Sites Committee	— W. K. W. Baldwin
O.F.N.C. Representative to A.A.A.S. Council	— V. E. F. Solman

Report of the Publications Committee

Since the last report of Council, four numbers of The Canadian Field-Naturalist have been published. These included the last two numbers of Volume 78 which contained 152 pages and the first two numbers of Volume 79 which contained 158 pages, or a total of 310 pages in all. Papers, notes and reviews were distributed as follows:

	PAPERS	NOTES	REVIEWS
Botany	6	2	5
Entomology	0	0	1
Herpetology	7	4	2
Ichthyology	2	0	3
Mammalogy	3	2	0
Ornithology	7	12	8
Miscellaneous	6	1	7
	31	21	26

The editor has reported that Volume 79 Numbers 3 and 4 will be published before the end of the year. Adequate manuscripts are on hand for at least the first number of Volume 80.

Expenditures for the year were as follows:

Volume 78 (Nos. 3 and 4) and 79 (No. 1)	$3,983.59
Reprints for Volume 78 Nos. 2, 3 and 4) and 79 (No. 1)	1,243.41
Total	$5,227.00

The publication of THE CANADIAN FIELD-NATURALIST was materially assisted this year by a grant of $500 from the Conservation Committee of the Canadian National Sportsmen's Show. This assistance is gratefully acknowledged.

REPORT OF THE EXCURSIONS AND LECTURES COMMITTEE

Five meetings of the Committee were held in 1965 and four issues of the newsletter were released. Activities undertaken included six bird recognition classes, held under the leadership of Mr. George McGee; nine bird walks, including four of the ever popular Tuesday morning outings; an evening to observe frogs; a woodcock singing ground visit and a spring flower hike. The flower hike was a co-operative venture with the Macoun Field Club and drew some 55 enthusiastic youngsters and 20 adults.

The annual club dinner featured Dr. John S. Tener of the Canadian Wildlife Service as guest speaker. His excellent illustrated talk "Wildlife of East Africa" was enjoyed by 110 members and their guests.

At the request of the Federation of Ontario Naturalists the club undertook the task of preparing a record of Snowy Owl sightings during the 1964-65 winter. The more than 80 observations were recorded and collated by Miss Lois Kingston. These were then spotted on a map of the Ottawa area and sent to the F.O.N.

A planned series of outings to observe shore birds during the fall migration period had to be cancelled due to the unusually high water levels which flooded the places where these birds normally feed in their passage through the area.

Plans for the winter season include some further bird recognition classes and "an introduction to wild plants" series.

REPORT OF THE RESERVE FUND COMMITTEE

Our total holdings remain unchanged from last year. These are 28 shares of Bell Telephone Stock and $3,000 in Ontario Hydro 3% bonds.

REPORT OF THE MEMBERSHIP COMMITTEE

Sixty-four new active members were added during the year. Of these, 18 were local, 25 were individuals outside of Ottawa and 21 were institutions. Deletions totalled 20. Of these, 5 were due to death, 7 resigned and 8 were in arrears for 3 years. On November 23, 1965, Council unanimously elected Mr. Hoyes Lloyd an honorary member. The membership now consists of:

Patrons	2
Honorary	5
Life	10
Affiliated Societies	9
Active — local individual	173
— local institutional	14
— Outside individual	253
— Outside institutional	286
Associate	36
Total	788

Four editions of the Club newsletter were distributed during the year. Information brochures and application forms were distributed to interested persons.

REPORT OF THE BIRD CENSUS COMMITTEE

The Club's forty-sixth consecutive annual Christmas Bird Count was held on Saturday, January 2, 1965.

A total of 6754 birds of 45 species were reported compared with 5893 birds of 52 species in the previous year. The number of individuals and the number of species are both somewhat higher than the 10 year average.

Three new species were added to our all time list which now totals 92 species.

A total of 41 persons in 13 parties took part in the count.

The results of the count were reported to the National Audubon Society and have been published in the Audubon Field Notes. The results were also published in the February 1965 Newsletter and were made available to the Kitchener-Waterloo Club for inclusion in a tabulation covering some 26 clubs in Ontario.

REPORT OF THE MACOUN FIELD CLUB COMMITTEE

Under the direction of Mr. A. A. Ellis, with assistance from Mr. G. Tessier and Mr. S. D. MacDonald, and latterly also of Mr. M. Shcheponek, all of the Museum staff, and of Mr. H. Groh of the O.F.N. Club, the activities of the Macoun Field Club have proceeded normally. A few spring and fall excursions to outlying points, notably one with the Field-Naturalists into the Gatineau Hills, have been held. The usual indoor sessions of the three age groups have continued with good satisfaction.

The High School group meets late Friday afternoons, with increased numbers except perhaps of girl members. Program varies from fairly technical presentations by outside specialists to those of members on their own projects; or to showings of slides and films.

The other groups, in turn on Saturday mornings, usually have capacity attendance to receive less advanced fare, and on alternate weeks to present their own observations and specimens, with their necessary comment, followed by discussion. By member vote, credits are earned toward badge or other standing.

The nucleus of a library has recently started through the generosity of the Kiwanis Club of Rideau which is also presenting instruments and otherwise joining the present sponsors in under-writing the costs.

The seventeenth birthday party was well attended and was featured by a presentation to Mr. Groh for continuous service to the Club and its Little Bear, of a scroll bearing the signatures of Mr. McGee and Dr. Glover, for the sponsoring organizations.

The annual invitation to its dinner by the Senior Club, brought along the usual exhibits from members and a report by President John Robertson.

Elections for the ensuing year resulted in selection of the following: President, Senior, Robert Sprules; Intermediate, Chris Fyles and Junior, Darrell Larose, with supporting Executives.

REPORT OF THE F.O.N. AFFAIRS COMMITTEE

No official joint activities of the F.O.N. and the Ottawa Field-Naturalists' Club were held in 1965.

Eight members of the O.F.N.C. attended the annual meeting of the F.O.N. held at Queen's University, Kingston on April 24 and 25, 1965. Four members including the President of the O.F.N.C. attended the Federation gathering at Point Pelee National Park on May 9-10, 1965.

Sale of 42 dozen Christmas cards gave the O.F.N.C. a return of $10.50. Sale of 1965 Christmas cards is in progress at date of this report.

REPORT OF THE PUBLIC RELATIONS COMMITTEE

Notices of forthcoming Club activities were submitted each month to "What's On In Ottawa".

An account of one of the Club's early morning bird walks was prepared for the Public Relations Officer of the National Capital Commission.

Most liaison with Ottawa newspapers was handled direct by the President and other Club members.

REPORT OF SITES COMMITTEE

An active subcommittee headed by Dr. J. M. Gillett had several meetings following up Mrs. Sheila Thompson's submission to Council on Gatineau Park. Continuing co-operation of National Capital Commission management was obtained.

The chairman served on Dr. J. S. Row's advisory committee to the N.C.C. on the Mer Bleue mire following submissions of several years standing from our Club. A full report to N.C.C. directors was produced July 21, 1965. It is highly important that 1966 Council obtain N.C.C. report on progress made on Rowe Committee recommendations in view of long delayed action upon our Club's original proposal. The preservation and management of the Mer Bleue is an urgent matter: further delays will leave little worth preserving in this classic locality of Canadian natural history.

The Chairman visited the Bronson Avenue Bridge hackberry site with assistant city arborist following a report from Dr. W. G. Dore. Our President was advised upon communication with City of Ottawa regarding the death of the veteran tree and the preservation of root sprouts in accordance with city ordinance to preserve this site as nearly as possible in a natural state. Rediscovery of our Club's files covering the period of first communication with Mayor and Council should prompt further action by 1966 Council.
No formal meetings of the committee were held.

A. W. RATHWELL, *Secretary*

STATEMENT OF FINANCIAL STANDING
THE OTTAWA FIELD-NATURALISTS' CLUB 30 NOVEMBER 1965

CURRENT ACCOUNT

Assets		Liabilities	
Balance in Bank 30 Nov. 1965	$ 6,887.83	Cheques Outstanding	$ 220.64
Bills Receivable	118.22	Balance	6,785.41
	$ 7,006.05		$ 7,006.05

Receipts			Expenditures	
Balance in Bank 30 Nov. 1964		$ 3,729.87	Can. Field-Naturalist (3 nos.)	$ 3,983.59
Fees: Current	$3,152.25		Separates & Illustrations	1,243.41
Arrears	105.00		Editor's Honorarium	200.00
Advance	514.65		Business Manager's Honorarium	100.00
Associate	111.00		Excursions & Lectures Committee	41.13
		3,882.90	Macoun Field Club	124.34
Separates & Illustrations		2,588.22	Clerical Assistance for Treasurer	46.95
Sale of Back Numbers		1,677.81	Postage & Stationery	298.24
Geology of Ottawa District		138.30	Bank Discount	30.45
Geology of Gatineau-Lièvre		17.75	Miscellaneous	143.64
Field Checking List/Birds		16.00	Balance in Bank	
Donations: Sportsmen's Show		500.00	30 Nov. 1965 $6,887.83	
Kiwanis Club of Rideau for Macoun Field Club		80.00	Less Cheques o/s 220.64	6,667.19
Macoun Field Club Collection		21.00		
Miscellaneous		227.09		
		$12,878.94		$12,878.94

RESERVE FUND

Assets		Liabilities	
$3,000 Ontario Hydro 3% Bonds, market value	$ 2,815.00		
28 Shares Bell Telephone Stock, market value	1,618.50	Nil	
Balance in Bank 30 Nov. 1965	301.68		
	$ 4,735.18		

Receipts		Expenditures	
Balance in Bank 30 Nov. 1964	$ 150.59	Safety Deposit Box Rental	$ 5.00
Bank Interest	4.49	Balance in Bank 30 Nov. 1965	301.68
Ontario Hydro Bond Interest	90.00		
Bell Telephone Dividends	61.60		
	$ 306.68		$ 306.68

PUBLICATIONS FUND

Assets		Liabilities	
$1,500 Ontario Hydro 3% Bonds, market value	$ 1,391.25		
5 Shares Bell Telephone Stock, market value	289.13	Nil	
Balance in Bank 30 Nov. 1965	136.89		
	$ 1,817.27		

Receipts		Expenditures	
Balance in Bank 30 Nov. 1964	$ 78.53	Balance in Bank 30 Nov. 1965	$ 136.89
Bank Interest	2.36		
Ontario Hydro Bond Interest	45.00		
Bell Telephone Dividends	11.00		
	$ 136.89		$ 136.89

Audited and found correct (Signed)
J. M. Gillet and R. J. Moore, Auditors

(Signed) Anne Banning, Treasurer

REVIEWS

The Continents We Live On: Europe: A Natural History

By Kai Curry-Lindahl. Random House, New York, 1964. 299 pp., 264 photographs, 108 in colour. $20.00.

This is a magnificant book: the second of a series dealing with the climate, topography, vegetation and fauna of the continents (*North America* has already been published). It is difficult to imagine a pictorial treatment of Europe without a single picture of a cathedral, or crowded street. However, Europe's magnificant scenery and colourful birds and mammals shine through on each page without a sign of man's occupancy, unless it's the feral goats, horses and cattle on the stony plains.

Along with spectacular photographs by Europe's leading photographers is a text which explains the ecology of the diversified regions found in Europe from the Arctic tundra, taiga and hardwood forests, to the arid macchia of the Mediterranean and the high grassy steppes of southeast Russia. A highlight is the pictorial essay on the devastating ruin of the natural environment in the Mediterranean region over the past two thousand years by man's thoughtless action. The author titles the chapter "Eden in a ruined landscape".

A. W. F. Banfield
National Museum of Canada,
Ottawa, Ontario.

The Great Arc of the Wild Sheep

By James L. Clark. University of Oklahoma Press, Norman, Oklahoma. 1964. 247 pp. ($9.00 in Canada)

This small book attempts to discuss the physical features and distribution of all recognized wild species and subspecies of the genus *Ovis*. In it the author, better known for his museum preparations and sculpting of large mammals, follows the distribution of wild sheep from the Mediterranean through Central Asia and western North America south to Mexico, describing each form in turn. Unfortunately his knowledge of taxonomy is somewhat limited. For example he states that "Recent opinion considers it impossible for two distinct species to inhabit the same ground without intergradation and the loss of their identities". Also, concerning the northern part of the range of *Ovis ammon* he says ". . . there is such a congestion of subspecies that they frequently overlap". Such statements lend little to the scientific credulity of the book.

A serious error involves the distribution and type locality of *Ovis canadensis auduboni*, the Black Hills bighorn, which Clark asserts was distributed from Washington to the Dakotas and therefore ". . . must have transgressed right across the range of *Ovis canadensis canadensis*." This would be a rather improbable relationship for two subspecies of the same species. Actually the range of *auduboni* included, within historic times, only eastern Montana, western North and South Dakota, and possibly extreme northwestern Nebraska. Clark also states that the type specimen of *auduboni* was taken near Mount Adams, Washington, whereas that is really the type locality of *californiana*. His claim that the California bighorn is now believed to be extinct contrasts with the fact that at least 1200 are found in British Columbia alone. Statements to the effect that wild sheep do not migrate, that they feed throughout the night and that their greatest enemy is the wolf cannot be accepted without reservation. In stating that the life expectancy of *Ovis nivicola* is 14 to 15 years, Clark has confused life expectancy with maximum longevity. Generally in wild sheep, actuarial life expectancy (at birth) is about one half as great as maximum longevity.

Among the author's more admirable contributions is his attempt to dispel the old belief that sheep can be divided into round-horned and triangular-horned groups. One of the most valuable features of this book is its series of 82 illustrations, including photographs of live, hunter-killed and mounted whole specimens, as well as mounted heads and skulls. These give a valuable insight into the external features, particularly horn form, of the Asiatic varieties not familiar to North American workers. Equally intriguing are numerous hunting tales interjected through the text.

Reading this book has left a couple of thoughts foremost in my mind. Firstly, there is need for a world revision of the genus *Ovis*. Secondly, the book does not live up to its publishers claims as an "invaluable tool for the scientist", particularly if the reader notes the frequency with which the author uses the expression "is said to be". All in all it is pleasant reading; an interesting but not essential addition to the library of biologist or layman.

DONALD A. BLOOD

Canadian Wildlife Service
742 Federal Building
Edmonton, Alberta

The Molds and Man, An Introduction to the Fungi

By CLYDE M. CHRISTENSEN. Third Edition. Minneapolis, University of Minnesota Press. 1965. 14 plates, 284 pp. $5.50.

If you have ever asked a mycologist to tell you about his field of study and been overwhelmed by his stumbling attempts to simplify his professional jargon so that you can understand him, you will turn with relief to Christensen's *The Molds and Man*. And if you are the mycologist who was asked, you will be happy to allow Christensen to act as your spokesman.

Christensen writes as if he were chatting casually. The informality of his style is deceptive, however, for there is careful organization in his presentation of the facts of life in the world of fungi. This is the third edition of the book. It differs from the first by the addition of commendable chapters on "Toxic Fungi" and "Experiments with Fungi", and the re-writing of his discussion on "Fungi in foods and building materials". The appendix on classification, omitted in the second edition, is again included, unchanged.

The author has prepared the book, he says, for "not only beginning students in mycology . . . but all those who, either for practical reasons or for pure enjoyment, might want to get acquainted with these prevalent and interesting and often important plants". And these are the readers who will profit most from reading his book. The jacket claims it an "ideal textbook" and "a convenient reference book". It is neither, nor does the author intend it to be; but it is a most readable introduction to the fungi.

Granted, Christensen's wit degenerates at times into slapstick, and his simplicity of style into triteness and slang. Granted, the author dwells somewhat sadistically on facts and figures about ever-present voracious fungi bound to terrorize any reader not inured to horror by a daily diet of modern T.V.; and then, perversely, he scoffs at man's fears about biological warfare directed against man himself instead of insects. Granted that the professional biologist may feel uncomfortable in the frankly anthropomorphic and teleological atmosphere of the book. Granted also that the author entertains mainly himself and other initiates by indulging in today's popular game of baiting the taxonomist, with the result that part of his chapter on classification leaves the mycological noviciate, to whom the rest of his book is directed, feeling like an outsider listening to an "in-joke".

Granted these and other minor failings, Christensen has achieved what many others have been unable to do: write a book that the non-specialist not only can understand but will also want to read from beginning to almost the end. Grate-

ful for the rare talent he displays, we cannot demand more than he can give. In his preface he says: "To me, the study of fungi has been more than just a professional occupation — it has been absorbing, enriching, stimulating adventure. I should be glad if some of this feeling, at least, I had managed to pass on to the reader". He has — triumphantly.

LUELLA K. WERESUB
Plant Research Institute
Central Experimental Farm
Ottawa, Ontario

Birds of Prey of the World

By MARY LOUISE GROSSMAN and JOHN HAMLET. *Photographs* by SHELBY GROSSMAN. Clarkson N. Potter, Inc., New York. 1964. 496 pp. 70 color photos, 283 photos in duotone, 646 silhouettes, 425 range maps. $25.00.

This imposing volume is sure to delight everyone who is in any way interested in the birds of prey. It is a well-written, non-technical treatment of all the birds of prey of the world. It deals with 289 species of Falconiformes (hawks, eagles, vultures) and 133 kinds of Strigiformes (owls). It is magnificently illustrated and has many striking close-up color photographs, some of which are spectacular.

It is an ambitious book, measuring $9\frac{3}{4}$ by $12\frac{3}{4}$ inches, and divided into two main sections. Part I takes up the birds of prey from the beginning with an absorbing account of their geological and evolutionary history. It contains also a well-researched chapter on the birds of prey in art and religion and includes a history of the noble art of falconry. There is a fascinating and up-to-date treatment of the complex ecology of the subjects. Another chapter deals with their remarkable adaptations to suit their various ways of life, these often dramatically illustrated. The chapter on conservation should be read by everyone who has any interest at all in these rapidly decreasing birds, and above all by those who are quick to condemn them.

Part 2 is a field guide and atlas. For each genus there is a general description. For each species there are succinct descriptions of adults and immatures with color names keyed to an actual color chart; also information on habits, nesting, and distribution. Some 646 silhouettes are used to show the flight aspects of adults and young and there are numerous photographs and sketches showing other postures. About 425 range maps indicate broadly the breeding distribution in the world (the maps of the ranges of the White-bellied and Pallas' Sea Eagles are reversed, however).

There is a useful 13-page bibliography and a 12-page index. The latter is detailed but has a few faults. For example, the reader looking up Goshawk (*Accipiter gentilis*) will fail to find it under 'g' but instead it appears under 'n' for Northern Goshawk! The Rough-legged Hawk (*Buteo lagopus*) also is indexed under 'n' for northern.

The authors, photographer, and publishers have produced in this volume a handsome tribute to a magnificent group of birds, many of which are now in deep trouble and rapidly decreasing largely through the thoughtlessness and destructiveness of man.

W. EARL GODFREY
National Museum of Canada,
Ottawa, Ontario.

A Checklist of Canadian Atlantic Fishes with Keys for Identification

By W. B. SCOTT and M. G. SCOTT. Contribution 66, Life Sciences. Royal Ontario Museum—University of Toronto. University of Toronto Press, 1965, 106 pages, 2 figures, $1.25.

The rich fish fauna on Canada's Atlantic coast has been known since Cabot's voyage of discovery in 1497. Although keys to the fishes of Canada's Pacific and Arctic coasts have been in print for several years, there has been no key to the fishes of the Atlantic coast of Canada. Students of ichthyology have had at hand keys in V. D. Vladykov and R. A. Mackenzie's (1935) *The marine fishes of Nova Scotia* and H. B. Bigelow and W. C. Schroeder's (1953) *The fishes of the*

Gulf of Maine (as well as several checklists). But these keys covered only portions of the area.

The Scotts' publication provides both a checklist and keys to the fishes of the Canadian coast between Cape Chidley, northern Labrador and Georges Bank, off southern Nova Scotia. The list includes 115 families and 300 species, several previously unrecorded from the area. Some freshwater fishes known to venture into the sea are included, e.g. *Lepisosteus osseus*.

Several keys are given. The initial key is for the major categories and is followed by keys to the species of cartilaginous fishes, a key to the orders and families of bony fishes, and, lastly, a key to the species of bony fishes. This arrangement saves effort for those who can identify their specimens to family. The key to the Myctophidae is by Isobel Radforth.

Following the keys is a short list of general and critical works with additional information which will assist in identification. The only important omission is Backus' (1957) *Fishes of Labrador*. Last is a useful item, an index to species and higher taxa.

The list and keys have been assembled with care. The classification is generally conservative. Regan's ordinal names are used, although Berg's names are included in parentheses. Recent revisions of the Osmeridae and Cottidae are not followed nor are the reasons for not doing so given. The Scotts do not use Rosen's new order Atheriniformes. Subspecific names are not generally given.

The keys are well constructed, usually employing several firm characters. External characters appear to have been emphasized. Non-technical terms are commonly used instead of technical terms, e.g. saw-toothed instead of serrate. There are occasional lapses, e.g. in each of the couplets separating the species of *Gasterosteus* the dorsal spine counts are indicated as 3.

The authors have coined several common names for species lacking them, always a difficult job. These are generally acceptable but some are less than concise – American straptail grenadier for *Malacocephalus occidentalis*, and Alfonsin a Casta Larga for *Beryx decadactylus*. English but not French common names are given in the text and keys, along with scientific names.

The Scotts' paper should help advance ichthyology on the Atlantic coast of Canada and is a useful contribution to the growing number of Canadian faunal works.

D. E. McALLISTER
National Museum of Canada
Ottawa, Ontario

OTHER NEW TITLES

The University of Iowa Studies in Natural History

Volume 20 Number 7 pp. 1-65. August 1965.
Contents: *Floristic relationships of New Caledonia*. By Robert F. Thorne.

Vascular plants collected by R. F. Thorne in New Caledonia in 1959. By A. Guillaumin, R. F. Thorne and R. Virot.

Canadian Society of Wildlife and Fishery Biologists Occasional Papers No. 1

Editor: M. I. MYRES. October, 1965. (Mimeographed) *Content*: W. O. PRUITT: The Ecology of Snow; R. Y. EDWARDS: Wildlife Management in Parks; W. W. JEFFREY Wildland Watershed Management and Wildlife and Fishery Biology: Some Common Interests and Potential Conflicts; W. A. BENSON: ARDA and the Use of Marginal Agricultural Land; G. R. FRANCIS: The Canadian Council of Resource Ministers: An Innovation in Resources Administration. ($0.50, obtainable from M. T. Myres, Department of Biology, University of Alberta at Calgary, Calgary, Alberta).

NOTES

Unexplained Reptilian Mortality

At the edge of Pearson marsh, two miles south of the village of Harlowe, Barrie township, Frontenac county, Ontario, there is a boggy habitat where Four-toed Salamanders (*Hemidactylium scutatum*) resort in springtime to lay their eggs. Within a few yards of this habitat and on slightly higher ground extending along the north shore of this extensive marshland were found, on May 17, 1959, the remains of twelve Northern Water Snakes (*Natrix sipedon sipedon*), several of which had obviously died only recently while others had evidently been dead longer, perhaps for several weeks. One specimen about twenty-eight inches in length had apparently attempted to crawl down a hole under an old rotted stump, located on a gently sloping grassy bank within six feet of an 8 x 12 foot water hole connected with Pearson marsh. The snake had managed to get one-third of its length down the hole before it died. When observed on May 17 it was badly decomposed. The stump may possibly mark a hibernating site for water snakes.

Within a small area, ten to twenty feet from the water hole and stump, the writer found five of the snake carcasses. These averaged about twenty-two inches in length. The others lay scattered singly up to a distance of fifty feet away. Examination of those reptiles which had died most recently revealed no signs of external injuries (heads and necks intact), but the earlier ones showed evidence of having been partly eaten, presumably by foraging animals, and were in an advanced state of decay. About one hundred feet distant there was an active two-foot water snake, the only live snake seen that day in the vicinity. As the snake remains showed varying degrees of decomposition, they had obviously not all perished at the same time.

During the last two weeks of April (1959) the Harlowe district experienced a succession of abnormally warm days followed quickly by cold freezing weather. It seems unlikely that the snakes, having first been tempted to venture forth from their hibernating dens by the sudden warmth, would be killed by the return of the cold weather. Had this happened all the carcasses would have shown similar degrees of decomposition. It could have been that the population succumbed to some reptilian disease. It has been well established that many pesticides can easily be water-carried for considerable distances. Perhaps the reptiles had, in some manner, come into contact with these highly toxic substances. An investigation of the immediate area failed to reveal any similar mortality amongst the other representatives of the local herpetofauna.

There appears, at present, no satisfactory explanation of the death of the twelve water snakes within so small an area.

Robert V. Lindsay

86 Quebec Avenue
Toronto 9, Ontario
8 March 1965

New Records of Leeches (Hirudinea) for Saskatchewan

During the past year the writer examined a number of samples of leeches collected in the Province of Saskatchewan and these studies have revealed the presence of three species previously unrecorded for the area. Oliver (1958, Canadian Field-Naturalist 72: 161-165) published a report which indicated that a total of 20 species were known from Saskatchewan. The new species record-

ed here are *Glossiphonia heteroclita* (Linnaeus) 1758, *Oculobdella lucida* Meyer and Moore 1954 and *Placobdella ornata* (Verrill) 1872.

Glossiphonia heteroclita was taken in a pothole near Melfort, Saskatchewan by Mr. D. R. Foskett on May 4, 1963. Only one specimen was obtained and it has been identified by Dr. M. C. Meyer of the University of Maine. This is a small species of *Glossiphonia* which has been reported from only a few parts of Canada. Meyer and Moore (1954, Wasman Journal of Biology 12: 63-96) record it from Canvasback Bay, vicinity of Winnipeg, Manitoba and refer to its presence in three localities in Ontario and one in Quebec.

Oculobdella lucida was collected by Mr. D. R. Foskett in two potholes near Saskatoon, Saskatchewan, in single potholes near Melfort and Swift Current and also in a beaver dam on a creek east of Unity, Saskatchewan. The only other records of this species are from one locality in Manitoba (Meyer and Moore, 1954) and from several lakes and ponds in Alberta, (Moore, 1964, National Museum of Canada, Natural History Paper 27: 1-15). It may be that *O. lucida* is confined to the Prairie Provinces of Canada but more extensive collecting in the neighboring States of the U.S.A. could well reveal its presence there.

Placobdella ornata was found by Mr. D. J. Buckle in a lake (known locally as Sqaw Lake) near Lady Lake, Saskatchewan, on May 7, 1962 and by Mr. D. R. Foskett in a pothole near Melfort, Saskatchewan, on June 10, 1963. Meyer and Moore (1954) refer to its occurrence in five provinces from Alberta on the west to Nova Scotia on the east so this species is widely distributed across the Dominion.

Oliver's paper (1958) contains no mention of *Macrobdella decora* in Saskatchewan but it may be mentioned here that this species is known from three localities in the Province. The earliest record is that mentioned by Moore (1922, Canadian Field-Naturalist 36: 6-11, 37-39) who reports four specimens collected on dore from the Qu'Appelle Valley, Saskatchewan, in the summer of 1907 by A. Halkett. The writer found two individuals of this species in Kenosee Lake, Saskatchewan, on June 29, 1938 and a single *M. decora* was taken by Mr. D. J. Buckle in the above mentioned lake near Lady Lake, Saskatchewan, on May 7, 1962. These records indicate that this species is to be found in the southern part of Saskatchewan.

J. E. MOORE

Box 307
Edmonton, Alberta
21 June 1965

A Black Swift Nest in British Columbia

ALTHOUGH the Black Swift, *Cypseloides niger* (Gmelin), is a summer visitor to much of British Columbia, there is apparently only one definite nesting record: Beebe (1959, Murrelet 40:9) reared and released a young bird which had been taken from its nest near Clinton.

On September 6, 1964 I discovered a Black Swift nest in the gorge of a small mountain stream 18 miles north of Vernon. It was situated on a shallow ledge of a low mossy cliff, about 9 feet above the stream bed and 10 feet downstream from a small waterfall. The single nestling was almost fledged, and was photographed by S. R. Cannings the following day (Figure 1).

The nest was visited again on the evening of September 8. Just at dusk (6:40 p.m., Pacific Daylight Saving Time) a parent bird darted up the gorge and plastered itself against the rock at the end of the nest towards which the nestling was facing. The latter immediately begged for food by bobbing its

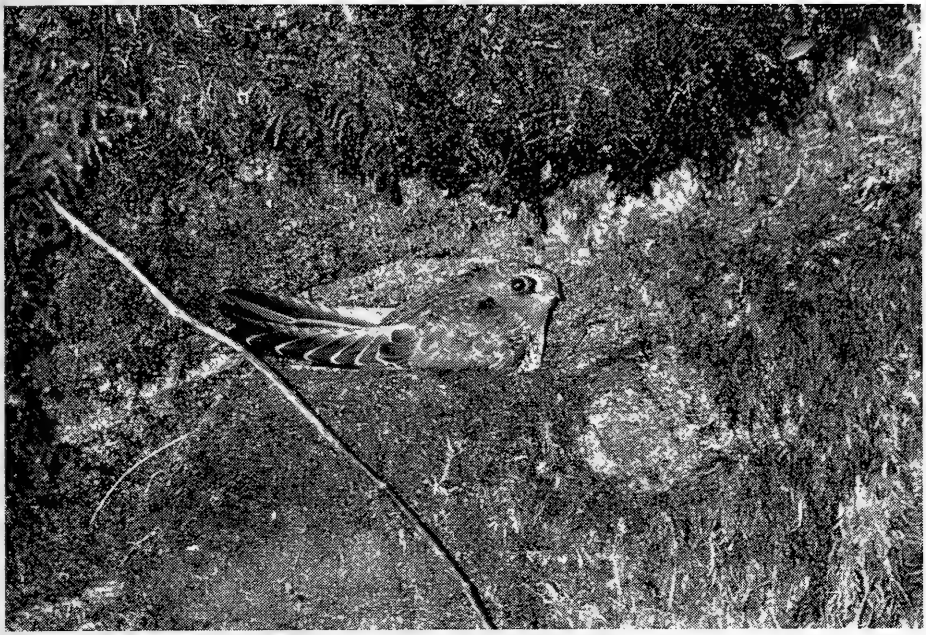

FIGURE 1. Young black swift in nest near Vernon, B.C., September 7, 1964.

head, but the presence of intruders only 12 feet away apparently alarmed the parent, as it remained motionless for almost a minute before feeding commenced. Food was pumped into the young bird at intervals during the next 8 minutes and at 6:51 the parent swooped downstream from the nest, then towered up through an opening in the forest.

The nest was visited briefly at 4 p.m. on September 10. The nestling was restless, constantly peering out from beneath the overhanging moss to watch the sky, preening diligently, and changing positions in the nest. Finally it backed out over the side, and clinging in a vertical position with the head thrown back, went through a series of prolonged and vigorous wing-flapping exercises. On September 12 the nest was empty.

JAMES GRANT

R.R. 2, Vernon, B.C.
30 March 1965

Short-eared Owl in Southern Baffin Island

ON JULY 2, 1965, I found a recently dead Short-eared Owl (*Asio flammeus*) near the townsite of Apex Hill, about three miles east of the airport, Frobisher Bay, N.W.T. Much of the head and breast had been eaten, and probably the owl was killed by another predator. A few of the Eskimos whom I questioned had seen the species in the Frobisher Bay region. They agreed that the bird was rare, but two well-travelled men believed that it sometimes nested on the south side of Frobisher Bay. Curiously, they had no name for the species, simply describing it as a small, brown *okpik* (Snowy Owl).

Kumlien (1879, U.S. National Museum Bulletin 15, p. 81) referred almost casually to Short-eared Owls (as *Brachyotus palustris*) nesting in southern Baffin

Island. Since they had not been seen by subsequent observers, this breeding record was understandably doubted by Snyder (1957, *Arctic Birds of Canada*, University of Toronto Press, p. 244). Possibly the species only reaches and nests on southern Baffin Island sporadically or cyclically.

Part of the right wing of the specimen has been deposited in the National Museum of Canada.

IAN A. MCLAREN

Marine Sciences Centre
McGill University
Montreal, Quebec
19 August 1965

An Unusual Number of Dead Ring-billed Gulls

ON AUGUST 13 and 14, 1964, I counted dead gulls on the shore of Lake Ontario from the Whitby town line to approximately three quarters of a mile to the east and the same distance to the west. The shore here is from 20 to 50 feet in width and varies from rocky to sandy beach. There are steep banks up to 30 feet in height on the landward side of the beach.

In the count to the west, I tallied: Ring-billed Gulls (*Larus delawarensis*), 12 mature and 8 immature; Herring Gulls (*Larus argentatus*), 1 mature and 1 immature. In the count to the east, I tallied: Ring-billed Gulls, 2 mature and 1 immature; Herring Gulls, 1 mature and 1 immature. This is 22 dead gulls along three quarters of a mile of narrow beach, and 5 over the same distance in the opposite direction. Most of the gulls were Ring-billed.

The dead gulls were distributed fairly evenly along the shore. Half of them were within 200 feet of a nearest dead bird. The rest were up to 2,000 feet apart.

I have walked this beach from time to time over a period of 10 years and have noted dead gulls, but never in the numbers reported here. From the state of the carcases most of the birds had died over the summer. Also, the lake sweeps the beaches clean each winter which means the remains appeared there since then. One Ring-billed Gull found dead was banded as a young at the Bluffs, Ontario, on June 21, 1964.

Three gulls that were near death and 10 fresh remains were examined superficially. All were in good plumage and sound of limb but extremely emaciated.

The greater number of gulls on the West Beach may mean that more Ring-billed Gulls died on this area. Another possible explanation is that the East Beach was mainly an eroding shore and remains from here were deposited on the West Beach.

J. F. BENDELL

Department of Zoology
University of British Columbia
25 June 1965

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FURTHER OBSERVATIONS ON LARGE CANADA GEESE MOULTING ON THE THELON RIVER, NORTHWEST TERRITORIES

Ernie Kuyt
Canadian Wildlife Service, Fort Smith, Northwest Territories

The purpose of this paper is to present additional information on the race(s), origin, and migration routes of the Canada Geese which moult on the Thelon River, N.W.T.

Previous observations by this writer on the Thelon River suggested that non-breeding Great Basin Canada Geese (*Branta canadensis moffitti*) regularly summer and moult in the Central Canadian Barrens (Kuyt, 1962).

Scott (1950) mentioned the pre-moult migration of large Canada Geese into the Perry River District, 200 miles north of the Thelon River, as follows:

"Before the breeding season, parties of big Canada Geese (? *B. c. moffitti*) were seen migrating down the river. Four were found moulting with Lesser Canadas and Ross's and on the last day of July, a party of nine big Canadas was seen on the Perry already able to fly on new primaries. There was no evidence of breeding in the large race, but it was recognized by the natives as distinct from the Lesser Canadas. It is thought that non-breeding birds may continue northward this far in order to find suitable moulting territory."

Also relevant is a report by Cowan (1954) of the band returns from two Canada geese banded as juveniles in the Cariboo district, British Columbia, which is ascribed by Delacour (1954) to the range of *B. c. moffitti.* They were shot 250 miles northwest of Lookout Point, Thelon River, in the Bathurst Inlet area of the Northwest Territories, one as a yearling and one as a three-year-old.

A number of races of Canada Geese have been reported to inhabit the Thelon River area. Clarke (1940) found broods, and Hanbury (1904) found Canada Goose nests on the upper Thelon. Specimens taken there by Clarke were referred by P. A. Taverner to *B. c. leucopareia.* Delacour (1954) includes the Thelon River in the breeding range of *B. c. parvipes.*

Although I have seen several thousand Canada Geese in the Thelon River area during the summers of 1960 to 1964, I have never observed nests or young Canada Geese there. In recent years, the area appears to have been used solely as a moulting area for large Canada Geese.

Sterling (1963) noted that groups of Canada Geese in the Beverly Lake-Aberdeen Lake area of the Thelon River tended to remain segregated between successive aerial inspections. He suggested that each group of moulting geese may have been a distinct segment of a flyway or sub-flyway population.

Mailing date of this number: June 17, 1966.

PROCEDURES

During 1963 field studies of interrelationships between wolves and barren-ground caribou, I had the opportunity to band moulting Canada Geese on the Thelon River between Lookout Point (64°11′N., 102°33′W) and a point about 35 miles downstream. The moulting geese, usually encountered on the river, were slowly herded to shore and captured on land. A labrador retriever was used in the work, and of 140 geese banded, 72 were captured by the dog.

During the summer of 1963, R. T. Sterling, Ducks Unlimited, Saskatoon, carried out preliminary investigations on geese in the Beverly Lake-Aberdeen Lake sections of the Thelon River system, about 80 miles northeast of Lookout Point. On July 12, he captured 500 moulting Canada Geese from a flock of several thousand. Thirty birds banded previously were included in the catch. He kindly allowed me to examine the banding and recovery data on the 30 retraps.

In order to establish definitely that the Canada Geese observed on the Thelon River belonged to one of the larger races, I weighed 125 of the moulting birds captured in the Lookout Point area. Two geese accidentally killed during banding were submitted to H. C. Hanson for subspecific identification.

RESULTS

The distribution of weights, to the nearest half-pound, of live geese captured in the Lookout Point area, is given in Figure 1. The average weight of 65 males was 9.3 lbs., while the average weight of 60 females was 7.8 lbs. Average weight declined during the period of moult. For the first 20 males and 20 females banded, average weights were 9.4 lbs. and 8.0 lbs. respectively. Those birds had just begun to moult. For the last 20 geese caught, average weights were 8.9 lbs. for males and 7.4 lbs. for females. Those birds regained flight about one week later.

Among the 140 geese captured in the Lookout Point area were seven which had been banded previously. The information on the original banding of those seven birds is presented in Table 1 along with information on a single goose taken in 1960, and a previously unreported recovery from 1962.

Of the geese banded in the Lookout Point area in 1963, 17 were recovered during the hunting season of that year and 1964. Data on those returns are presented in Table 2.

Of the 30 recaptures taken by Sterling in the Beverly Lake-Aberdeen Lake area, 10 were banded at Rochester, Minnesota, one of the major wintering areas of the Giant Canada Goose (*B. c. maxima*), and 16 bands originated from waterfowl refuges in Missouri, Texas, South Dakota, Wisconsin, Arkansas, and Oklahoma. The remaining four geese were banded in southern Manitoba and Saskatchewan.

DISCUSSION

Hanson (1962) has discussed in detail the changes in body weight associated with moulting in Canada Geese. He treated flightless geese and newly flying

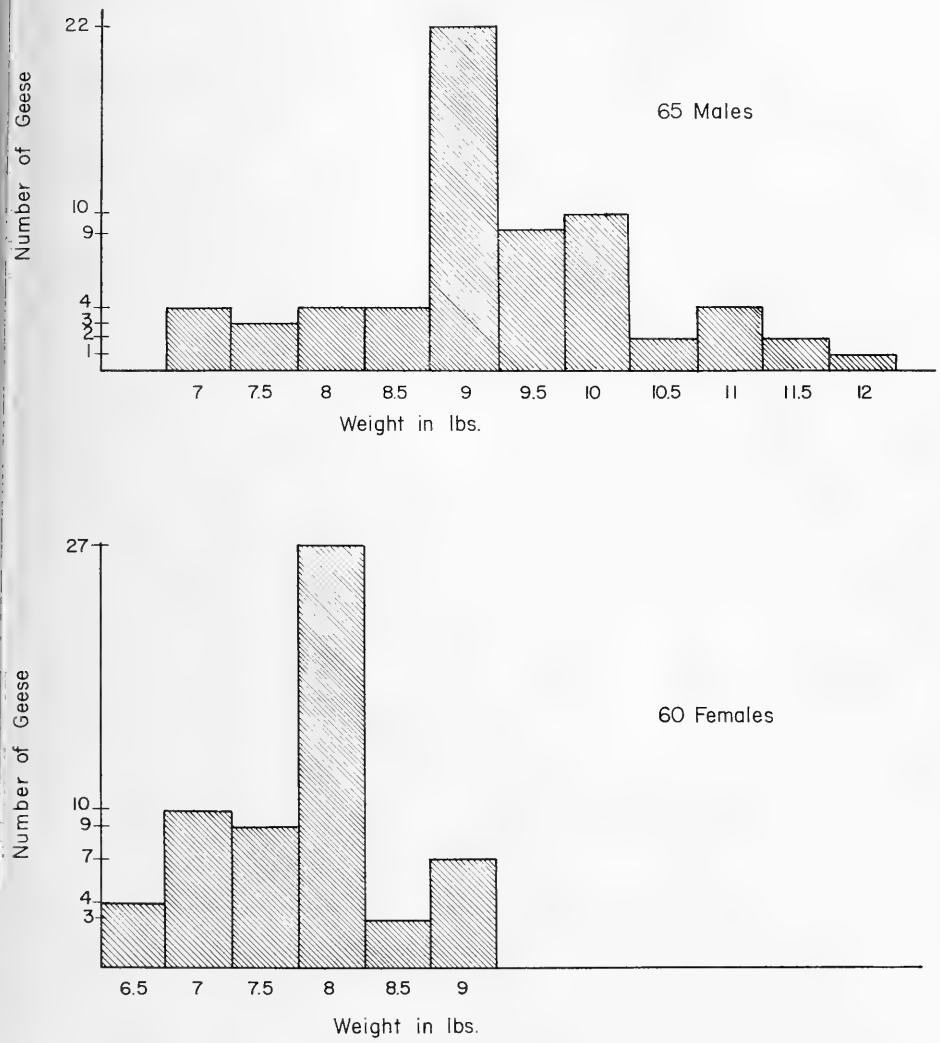

FIGURE 1. Distribution of weights within ½lb. classes of Canada Geese captured near Lookout Point, Thelon River, N.W.T.

birds which have not completed all of their feather moult as two distinct categories. Apparently under the stress of moulting, body fat reserves break down and the size of the pectoral muscles is reduced through protein katabolism. The weight of these muscles during the flightless period of the moult is 30 and 36 per cent less in males and 25 and 41 per cent less in females (for yearlings and adults respectively), than the average weights of these muscles at the end of migration. When flight is again possible, the weight of the pectoral muscles increases markedly.

TABLE 1. — Banded Canada Geese recaptured near Lookout Point, Thelon River, N.W.T.

Banding information			Recovery information		
Banded at	Date	Banded as	Recovered at	Date	Recorded as
Bowdoin Nat. Wildl. Ref. Malta, Montana	June 23, 1957	Local, male 518-45560	Thelon River, N.W.T. 64°21′N., 101°49′W	June 19, 1960	Male
Idaho, 43°30′N., 116°50′W	June 1, 1960	— 518-85821	L.O. Point, Thelon R. 64°11′N., 102°28′W	June 17, 1962	Female
Bowdoin Nat. Wildl. Ref. Malta, Montana	June 27, 1960	Young, female 528-27876	L.O. Point, Thelon R. 64°13′N., 102°37′W	June 25, 1963	Adult, female
Nebr. Game F. P. Com. Lewellen Area, Nebr.	Jan. 27, 1963	— 558-38317	Thelon River, N.W.T. 64°27′N., 101°44′W	June 30, 1963	Adult, male
Wyom. Game and Fish, Yoder, Wyom.	July 10, 1962	Young, 518-90016	Thelon River, N.W.T. 64°15′N., 101°56′W	June 29, 1963	Adult, male
Mont. G. and F. Dept. Lima Reservoir, Mont.	June 27, 1962	— 558-50204	L.O. Point, Thelon R. 64°11′N., 102°26′W	June 28, 1963	Adult, female
Idaho F. and Game Soda Springs, Idaho	July 2, 1962	Young, male 558-19491	L.O. Point, Thelon R. 64°11′N., 102°26′W	June 28, 1963	Adult, male
Wash. Dept. of Game Alderdale, Wash.	June 9, 1961	Young, 518-88894	L.O. Point, Thelon R. 64°11′N., 102°26′W	June 28, 1963	Adult, female
Utah, F. and Game Redmond Lake, Utah	June 26, 1962	Young, male 558-35612	Thelon River, N.W.T. 64°16′N., 102°39′W	July 18, 1963	Adult, female

TABLE 2. — Recoveries of Canada Geese banded on Thelon River, N.W.T.

Banding information			Recovery information	
Banded at	Date	Banded as	Recovered at	Date
Lookout Point area, Thelon River, N.W.T.	June 23, 1963	Adult, male 528-82230	Tampico, Mont.	Oct. 6, 1963
Lookout Point area, Thelon River, N.W.T.	June 23, 1963	Adult, male 528-82226	Bassano, Alta.	Oct. 14, 1963
Lookout Point area, Thelon River, N.W.T.	June 28, 1963	Adult, male 528-82256	Adrain, Ore.	Oct. 20, 1963
Lookout Point area, Thelon River, N.W.T.	June 30, 1963	Adult, male 528-82288	Zurich, Mont.	Oct. 30, 1963
Lookout Point area, Thelon River, N.W.T.	June 25, 1963	Adult, male 528-82241	Hanna, Alta.	Hunt season 1963
Lookout Point area, Thelon River, N.W.T.	June 29, 1963	Adult, male 528-82272	Chinook, Alta.	Hunt season 1963
Lookout Point area, Thelon River, N.W.T.	July 18, 1963	Adult, male 528-88944	Domremy, Sask.	Hunt season 1963
Lookout Point area, Thelon River, N.W.T.	June 30, 1963	Adult, male 528-82296	Loveland, Colo.	Dec. 18, 1963
Lookout Point area, Thelon River, N.W.T.	June 28, 1963	Adult, female 528-82265	Lamar, Colo.	Dec. 21, 1963
Lookout Point area, Thelon River, N.W.T.	July 18, 1963	Adult, female 528-88930	Wellington, Colo.	Mar. 7, 1964
Thelon River, N.W.T.	July 13, 1963	Adult, male 528-88911	Beverly Lake, Keewatin, N.W.T.	July 11, 1964
Thelon River, N.W.T.	June 28, 1963	Adult, female 528-82251	Beverly Lake, Keewatin, N.W.T.	July 11, 1964
Keewatin, N.W.T.	June 30, 1963	Adult, female 528-82290	Malta, Mont.	Oct. 4, 1964
Thelon River, N.W.T.	June 30, 1963	Adult, female 528-82292	Lethbridge, Alta.	Oct. 6, 1964
Thelon River, N.W.T.	June 28, 1963	Adult, male 528-82258	Rainier, Alta.	Oct. 9, 1964
Thelon River, N.W.T.	June 19, 1963	Adult, male 528-82221	Brooks, Alta.	Oct. 22, 1964
Thelon River, N.W.T.	June 29, 1963	Adult, female 528-82274	Foam Lake, Sask.	Nov. 16, 1964

Most of the 17 band recoveries from the 140 geese banded were made in the area which Delacour (1954) considers to be the range of distribution of *B. c. moffitti.* However, Hanson's information on the weight loss associated with moult suggests that most of the geese captured near Lookout Point would weigh more than 12 pounds in autumn. Mershon's (1925) discussion of autumn weights of "Large" Canada Geese shot in North Dakota in the 1880's suggests a weight range of 12 to 18 pounds for *B. c. maxima.* A review of the status and distribution of the large Canada Geese, now being completed by H. C. Hanson of the Illinois Natural History Survey, indicates that many western prairie populations are referable to *B. c. maxima.*

Ten geese recaptured by Sterling (1963) in the Beverly Lake area had been banded near Rochester, Minnesota where *B. c. maxima* was recently rediscovered. Thus it seemed possible that some of the birds captured near Lookout Point might be of that subspecies. That was confirmed by H. C. Hanson when he examined two geese accidentally killed during banding and identified them as *B. c. maxima.*

Of the 30 recaptures made by Sterling in the Beverly Lake area in 1963, 10 had been banded near Rochester, Minnesota and three in southern Manitoba. The remainder had been banded in waterfowl refuges in Missouri, Texas, South Dakota, Wisconsin, Arkansas and Oklahoma – known wintering areas of birds breeding in Manitoba (Sterling, 1963). The nine banded geese recaptured in the Lookout Point area had been banded in the Northern United States and six of these were recorded as having been banded as "young" or "locals" (Table 1). Thus all recaptures made on the Thelon River to date conform to the original thesis of a pre-moulting northward movement of non-breeding Canada Geese belonging to populations which breed in the northern United States and southern Canada.

It is noteworthy that all previously banded geese captured in the Beverly Lake-Aberdeen Lake area were banded *east* of the 101° meridian, whereas all of those captured near Lookout Point originated from United States refuges *west* of that line. Similarly, bands placed on geese in the Lookout Point area were recovered in Saskatchewan, Alberta, Montana, Oregon, and Colorado, in all cases west of 101° (Table 2). Two geese banded near Lookout Point in June and July 1963 were retrapped the following year at Beverly Lake. Those two retrapped birds are the only two from the Lookout Point banding *and* from Sterling's hunting season recoveries that have not followed the pattern of the other retraps. Since an east-west separation of about 70 miles exists between the two banding locations on the Thelon River system, the data indicate that the Lookout Point geese and those of the Beverly Lake-Aberdeen Lake area follow separate flyways in both spring and autumn migrations and that this segregation is generally maintained in the moulting area.

It would be valuable for management purposes to learn if the various groups of Canada Geese that moult on the Thelon River always follow separate migration routes, and where they rejoin the breeding populations with which they are associated. Towards those ends it would be useful to band samples of the moulting groups at various locations on the Thelon River.

The writer wishes to record his appreciation to D. R. Flook and A. Dzubin, Canadian Wildlife Service, and to R. T. Sterling, Ducks Unlimited, for suggestions in the preparation of this note.

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SOME FEATURES OF THE FLORA OF THE ISLANDS OF EASTERN LAKE ONTARIO

ROBERT HAINAULT
Fowler Herbarium, Queen's University, Kingston, Ontario

THE EIGHT LOW limestone islands under study extend in an east-west band of about 60 km length between Prince Edward County in Ontario and Jefferson County in New York (Figure 1). For purposes of the botanical survey, portions of the mainland areas, Long Point, Ontario, and Stony Point, New York, were included and comparison is made with the Kingston and other mainland areas where the flora is better known. Nobody has collected on these islands before. The field work was conducted in 1963 and 1964 and some results have already been reported (Hainault 1964). The nomenclature follows Gleason and Cronquist (1963). The collections are deposited in the Fowler Herbarium of Queen's University.

Abundant Southern Species

A good proportion of the species of the islands are unusual by their greater abundance as compared with the mainland in the vicinity of Kingston, about 35 km north. These plants occur even farther north but become widely scattered and uncommon.

For example, *Cardamine douglasii*, a species which reaches the Ottawa area, is found in nearly all the rich woods and brings considerable colour to an otherwise drab spring flora. *Podophyllum peltatum*, which blooms later, is also remarkably abundant on the islands. Near Kingston it seems peculiarly restricted to a band about 15 km wide along Lake Ontario and then peters out in patches down the shores of the St. Lawrence River.

Among the trees, *Acer nigrum* substitutes almost entirely for *A. saccharum*. Black maple is still common around Kingston but becomes much rarer north of that city.

Another southern plant which deserves mention is the high climbing variety of poison ivy, *Rhus radicans* var. *radicans*. It is very abundant in several places but is the much rarer of the two varieties in the Kingston region and farther north is known at only a few scattered localities along the lower Rideau (Ottawa, Ont.) and Ottawa rivers (Grenville, Que.).

Northern Extensions of Southern Species

These plants have the local northern limit of their range in Prince Edward County, although a few reach Montreal or even Lake St. Pierre. Most of them are absent in several counties west of Prince Edward but reappear farther west in the Toronto area or the Niagara Peninsula. They approach the islands rather by way of northern Oswego County, New York State.

Peltandra virginica was collected by John Macoun (1888:72) in the Belleville area in 1877 but it has not been seen there since. It is common on Long Point, Galloo Island, and Stony Point. It is also found in northern Oswego county and has been collected at one point in the Niagara peninsula (where it is perhaps introduced) by Bert Miller and others (Soper 1962). The plant is also found on Lake St. Pierre where it seems to have arrived by way of the Richelieu River.

Lindera benzoin is common in southwestern Ontario (Soper 1952). East of Toronto it disappears but is found again in several localities near Belleville. It grows on Stony Point and Beschel has found it in northern Oswego County.

Hibiscus palustris it probably the most spectacular flower of the area. In Ontario it has been reported only from the Lake Erie region (Soper 1962). At the eastern end of Lake Ontario it grows in New York State on Stony Island and Stony Point.

Valerianella chenopodifolia, formerly known only from Welland and Elgin Counties in Ontario and not collected since 1921 (Soper 1962), is common on Yorkshire Island, half-way across the lake, just on the Ontario side of the border.

Species of the Limestone Plains

The very thin soil in the area is characteristically covered by extensive stands of Canada bluegrass, *Poa compressa*. Bare patches of limestone are surrounded by striking zonations related to depth of soil. These "alvar" habitats (Beschel 1965) are also extensive in the terrain between Kingston and Belleville and contain several rare plants, ephemeral annuals or tuberous rooted

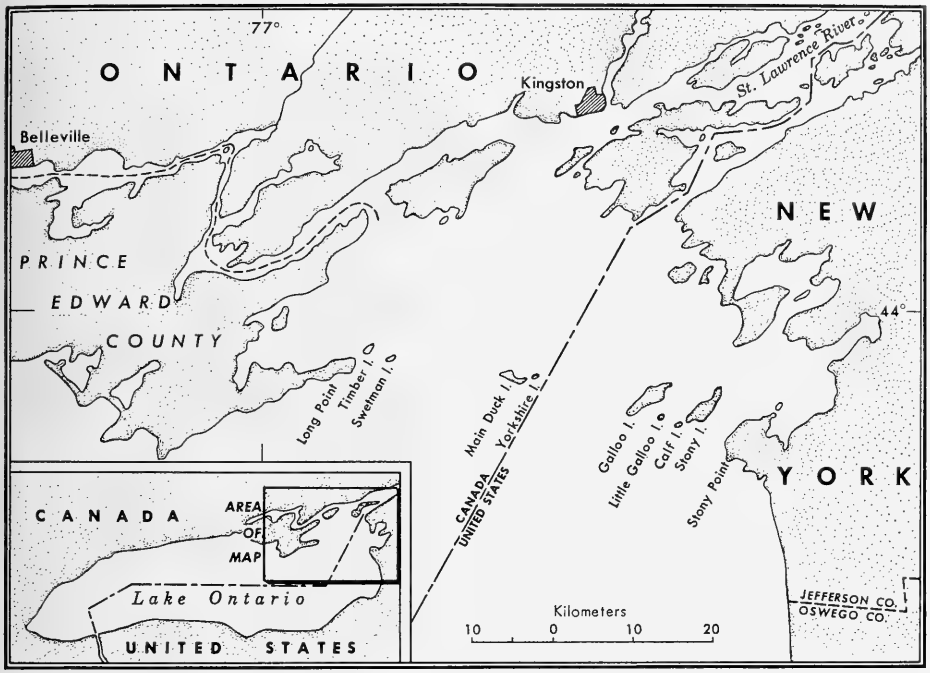

FIGURE 1. The island chain of eastern Lake Ontario.

perennials, essentially the same at all places. I will mention a few: *Eleocharis compressa*, *Ranunculus fascicularis*, *Myosotis verna*, *Isanthus brachiatus*, *Scutellaria parvula*, *Satureja acinos*, *Hedeoma hispida*, and *Triodanis perfoliata*.

Southern Extensions of Boreal Species

Certain widespread plants in the Canadian North become rare in southern Ontario; thus, a small forest of spruce and fir, *Picea glauca* and *Abies balsamifera* on Galloo Island is unusual in that it is surrounded by southern elements of the deciduous forest. Its presence indicates moderate acidity of the substrate as further shown by the presence of woodland sphagna and *Leucobryum glaucum*. *Agropyron trachycaulum*, *Stellaria longipes* and *Draba arabisans* are other locally common northern plants which favour, however, the calcareous substrate exposed on the shores.

European Introductions

The introduced flora is proportionately rich, perhaps because the early settlers going to the islands took with them all kinds of garden and farm plants which later escaped and became established. Stony Point is especially interesting as it has such alien plants as *Reseda lutea*, very common on roadsides, and *Rosa tomentosa*, reported in Eastern North America so far only from Prince

Edward Island (Gleason and Cronquist 1963: 383); it is common and seems to compete with *Rosa eglanteria* in colonizing old pastureland.

Lotus corniculatus is abundant on Galloo Island where it has recently been cultivated as forage for sheep.

Species Transported by the Indians

It is difficult to know what wild plants were used and carried from place to place by the Indians before the arrival of Europeans because ethnobotanical and historical information is so vague in regard to species but *Allium canadense* at least seems to have been distributed in that fashion. It is a non-fruiting wild onion poorly equipped to spread itself by natural means. In the area, it is found either around known Indian campsites or in other obvious places where the Iroquois must have landed when they used the chain of Islands to cross the end of Lake Ontario. The onion is found on Long Point, Main Duck Island, Yorkshire Island and Stony Island, but is absent on the mainland from suitable habitats away from the water routes. Its distribution is being studied in detail by W. G. Dore. The particular distribution of *Podophyllum peltatum*, as mentioned above, also suggests transportation by Indians.

DISCUSSION

The floristic affinities and special composition of the vegetation present two problems in particular which will be assessed more fully as the study progresses.

Insularity

The islands have had relative biological isolation in the past and this aspect should be reflected in the present day constitution of their flora. The relationship between species number and area when contrasted with analogous situations on the mainland should give a measure of the degree of this isolation in quantitative terms.

History of the Flora

The presence of southern elements seemingly isolated from occurrences farther to the west in the same latitude brings up the interesting question of their routes of migration. The assumed absence of these species in the tract westward along the shore of Lake Ontario between Prince Edward County and Toronto may be due to insufficient collecting. It is always difficult to prove the absence of a species, yet several botanists have visited this tract and the critical species are not revealed among their collections.

The possibility of a migration northward along the east shore of Lake Ontario (Dore *et al.* 1959) is more attractive and the arguments in its favour can be listed.

1. The northward extension of numerous southern species is quite continuous as far as northern Oswego County, e.g. *Peltandra virginica*, *Castanea dentata*, *Sassafras albidum*, *Lindera benzoin*, *Nyssa sylvatica*.

2. From there some of these elements jump westward to the islands which, in general, have a flora of southern character.
3. Such southern elements drop out in the same latitude farther westward in and beyond Prince Edward County where favourable conditions still prevail.

Migration could now be stabilized or still active. It is generally agreed that the "Carolinian" elements had a wider and more northerly distribution in the Xerothermic Period. The local isolation of certain species along the eastern end of Lake Ontario and as far north as the Ottawa valley today may be due to their persistence in special habitats during the subsequent general extinction. Why they did not persist in the region west of Prince Edward County, in the same latitude where the moderating effects of the lake should have aided their survival is still difficult to explain.

More knowledge is needed regarding former levels of Lake Ontario and the migratory customs of the Indians.

ACKNOWLEDGEMENTS

The Ontario Research Foundation and the McLaughlin Research Fund supported my study which is being supervised by Dr. R. Beschel. Mr. Guy Brassard assisted in 1963. Permission to work on the islands was kindly given by the owners and several agencies assisted with transportation.

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A STUDY OF WATERFOWL NESTING ON THE SASKATCHEWAN RIVER DELTA

GERALD H. TOWNSEND
Department of Wildlife Management, University of Wisconsin, Madison

THIS PAPER PRESENTS an evaluation of factors influencing nesting success in a floating-sedge habitat on a portion of the Saskatchewan River delta. Loss of delta wetlands is occurring at an accelerated pace through hydro-electric flooding and agricultural drainage (Smith, Dufresne, and Hansen, 1964), and this study of nesting success represents one phase of a larger study to evaluate the importance of such wetlands to waterfowl. Species selection of nest sites, dates of nest initiation and hatching, average clutch sizes, and nesting success were determined to provide background information useful in developing management procedures for marsh areas of the Saskatchewan delta.

The study area was part of a large marsh formerly managed for muskrats (*Ondatra zibethicus*) by the Hudson's Bay Company, and presently under joint management for muskrats and waterfowl by the Saskatchewan Department of Natural Resources and by Ducks Unlimited (Canada). The marsh (known locally as the fur lease) lies south of Cumberland House, Saskatchewan, and immediately south of the old channel of the Saskatchewan River (Figure 1). It includes about 500 square miles of shallow lakes, marshes, and stands of willow (*Salix* spp.) and balsam poplar (*Populus balsamifera*). A natural levee along the banks of the Saskatchewan prevents drainage of the marsh into the river, and the water levels of the adjacent marsh are usually from 4 to 10 feet higher than the latter. Precipitation averaging 16.9 inches per year (Department of Transport, 1964) and spring runoff are insufficient to maintain water levels on the marsh, and these sources are supplemented by river water brought along an upstream ditch. This and other ditches connecting the major lakes within the marsh were built in the late 1930's and early 1940's by the Hudson's Bay Company to distribute water through the marsh.

One of the 30 major lakes, Egg Lake, was chosen as the site of the nesting study (Figure 1). Its floating shoreline, largely of sedges (*Carex* sp.) or sedges and short willows, was typical of other lakes on the lease. Along part of the shore, phragmites (*Phragmites communis*) formed a tall border separating the open water from the sedge community behind.

Most islands were also of floating sedge, with varying amounts of willows interspersed. Several islands had a mixture of cattail (*Typha latifolia*) and sedge as co-dominants, and most had small patches of phragmites, often bordering parts of the islands.

Approximately 2 miles of shoreline including about 122 acres along the northwest portion of Egg Lake were searched for nests. In addition, 14 islands totaling 51 acres were searched, giving a total of about 173 acres under investigation.

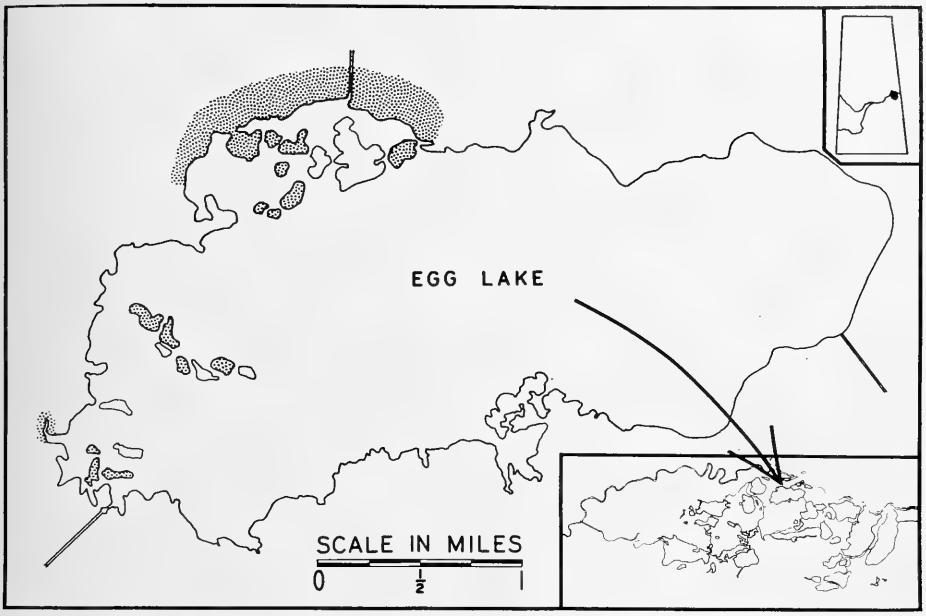

FIGURE 1. Map of study area. Dotted areas were searched for nests. Inset at lower right shows Egg Lake in relation to other lakes on the lease.

The present investigation was financed by Ducks Unlimited (Canada) and the University of Wisconsin. C. H. Moulder conducted a major part of the nest searching in 1963. Thanks are due J. R. H. Noble, who supplied unpublished climatic averages for Cumberland House. I am indebted to R. A. McCabe, J. J. Hickey, L. B. Keith, and W. G. Leitch for critical advice.

METHODS

Intensive nest searching was begun on 27 May 1963 and 25 May 1964. Two or three persons, walking abreast 20-40 feet apart, searched through the wet quaking marsh attempting to flush nesting ducks. Searching was confined to the morning hours, at a time when a high percentage of laying hens are found on their nests (Mendall, 1958; Sowls, 1955). Most nests, however, were discovered in the early stages of incubation, rather than during laying.

An effort was made in approaching nests to disturb the surrounding cover as little as possible. Each nest was identified by number and marked for subsequent visits with a tuft of sedge tied to a nearby willow. Nests were revisited every 7-10 days.

Individual nest histories were coded for data processing, and the computing facilities of the University of Wisconsin College of Agriculture were used in data analysis. Reference was made to Dixon and Massey (1957) and Steele and Torrie (1960) for statistical tests and tables of significance. Confidence limits, unless otherwise stated, are at the 95 per cent level of significance throughout the paper.

SUMMARY OF NESTS FOUND

A total of 225 nests belonging to 11 species of ducks were found on the study area. They include 89 Lesser Scaup (*Aythya affinis*), 49 Ring-necked Duck (*A. collaris*), 32 Blue-winged Teal (*Anas discors*), 15 Canvasback (*Aythya valisineria*), 13 Mallard (*Anas platyrhynchos*), and 7 Gadwall (*A. strepera*) nests. In addition, from one to three nests of Redhead (*Aythya americana*), Ruddy Duck (*Oxyura jamaicensis*), Green-winged Teal (*Anas carolinensis*), Pintail (*A. acuta*), and Shoveler (*Spatula clypeata*) were found. Three other species of ducks, Common Goldeneye (*Bucephala clangula*), Bufflehead (*B. albeola*), and American Widgeon (*Mareca americana*), were observed with broods on or near Egg Lake. Eighty-four nests were found in 1963, and 141 in 1964. Forty-three per cent were found on islands, although only 30 per cent of the total area searched comprised islands.

PHENOLOGY OF NESTING

Early-Spring Conditions

The old channel of the Saskatchewan River was already open when I arrived at headquarters camp on 4 May 1963; and in 1964 the ice went out here on 27 April. By 30 April 1964, the smaller shallow lakes had opened sufficiently to permit boat travel, and the edges of the larger lakes were melting. Egg Lake opened on 5 May 1963 and on 3 May 1964.

Early-nesting ducks must depend entirely on the previous year's vegetation for nest materials and concealment. Sedges and grasses are often flattened by the weight of snow, except near the bases of low willows, but after the first two weeks in May these old stems are soon pushed up somewhat by the new growth which gradually becomes apparent. By 20 May the new sedge is 6-10 inches high.

Hardstem bulrush (*Scirpus acutus*) on Egg Lake is, in general, not dense enough to provide suitable nesting cover for diving ducks. Stands present the previous fall that would seemingly provide adequate cover in spring usually fall short of this expectation. Cutting of stems by muskrats or ice action often completely removes the previous year's growth from beds of this emergent, and stems are windrowed along lake shores in spring. Small beds of floating bulrush that have torn loose from the bottom of the lake offer better nesting cover in the early spring than does anchored emergent growth. Ice action does not affect cover on these floating islands, and the few Canvasback nests found on Egg Lake in bulrush were here rather than in emergent stands. One or two other lakes on the lease, however, did have emergent stands of bulrush dense enough to support nesting ducks. Whether the high, spring density of old stems indicates a lack of ice shifting in these smaller lakes, or is due to a smaller density of muskrats, I do not know.

Cattail and phragmites do not flatten under the weight of snow and provide the best potential concealment during the first part of May. Nests of the early-nesting Canvasback were found in these cover types.

Water levels on the lease are generally highest just after breakup, due to late-fall buildup for muskrat management and to spring runoff. Egg Lake

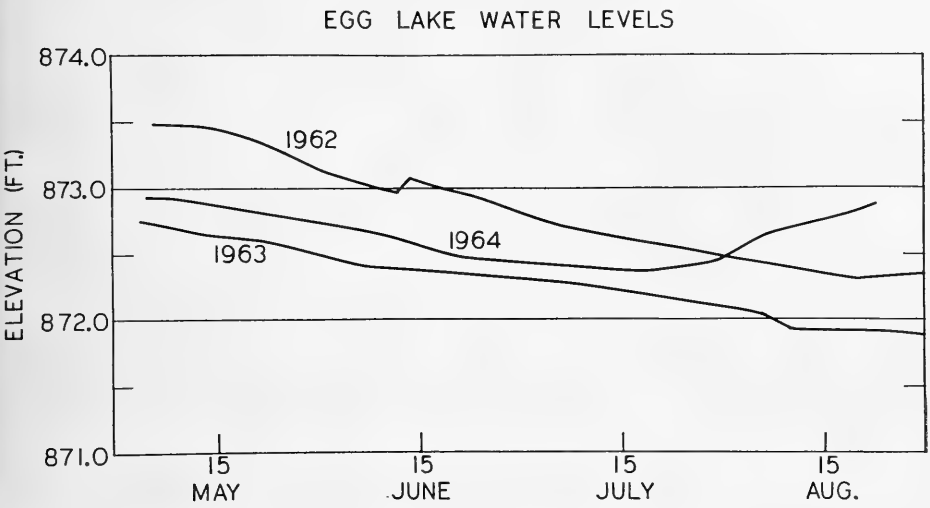

FIGURE 2. Water levels of Egg Lake during the summers of 1962-1964.

water levels typically decline progressively during the nesting season (Figure 2). Because much of the immediate shoreline of Egg Lake is floating, its relative wetness does not change significantly with fluctuating water levels unless the lake is so low that the floating mat comes to rest on the lake bottom. For about 2 weeks following breakup, however, these floating mats are frozen in the ice at lake levels existing the previous fall. Thus, any major increase in early-spring lake levels would probably flood the immediate shoreline and inundate the floating islands.

Waterfowl Arrival

Except for the White-winged Scoter (*Melanitta deglandi*), most species were present on the marsh when I arrived (4 May 1963, and 27 April 1964). The only specific observations of ducks recorded for the month of April came from Russell Robertson (Houston and Street, 1959, p. 199), manager of the lease. In 1959 he recorded the following arrival dates: Mallard and Pintail, 5 April; Lesser Scaup, 18 April; Canvasback, 28 April; and Blue-winged Teal, 6 May.

By the end of the first week in May 1963, Mallards, Canvasbacks, Goldeneyes, Pintails, Redheads, Gadwalls, and Green-winged Teal were paired and on territories. Scaups and Ring-necks were paired, but still remained in large groups on the lakes. By 20 May these latter species were on territories.

Dates of Nest Initiation

The histories of 60 nests in 1963 and 96 nests in 1964 were complete enough to backdate to time of nest initiation. No distinction was made between "first nests" and "renests." The earliest Mallard and Canvasback nesting records were 26 April and 1 May respectively, before ice breakup was complete and

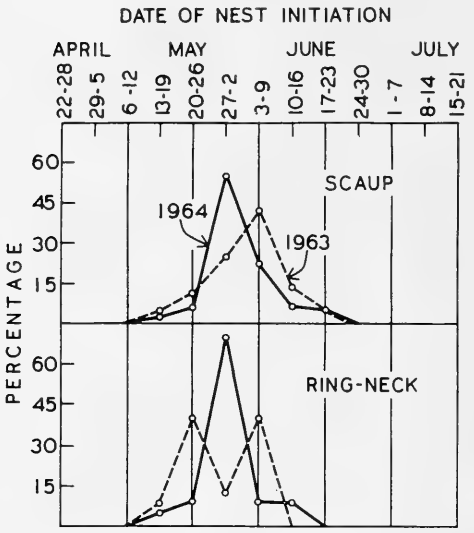

FIGURE 3. Percentage of Scaup and Ring-neck nests beginning each week in 1963 and 1964. Sample sizes include 28 Scaup nests in 1963 and 40 in 1964; and 15 Ring-neck nests in 1963 and 23 in 1964.

while the normally floating shorelines were still frozen in place. The earliest Blue-wing, Scaup, and Ring-neck nest records were 11 May, 15 May, and 16 May respectively. Mean dates when laying began during 1963 and 1964 respectively for 86 Scaup were 3 June $\pm$ 3 days and 2 June $\pm$ 2 days; for 38 Ring-neck, 30 May $\pm$ 4 and 31 May $\pm$ 3; for 19 Blue-wing, 26 May $\pm$ 8 and 1 June $\pm$ 3; and for 150 nests of all species, 1 June $\pm$ 2 and 31 May $\pm$ 2. Mean dates in 1963 were not significantly different from those in 1964 for any of the species.

The distribution of initiation dates for Scaup and Ring-neck showed differences between years, however, with the levels of significance approaching 85 per cent for Scaup, and 99 per cent for Ring-neck (Figure 3). On Egg Lake, Scaup apparently reached a nesting peak 1 week earlier in 1964 than in 1963, and I suspect that lack of renesting in 1964 caused this difference. Small-sample size might account for the extreme variation in the 1963 Ring-neck data.

Brood observations provided a more complete picture of nesting chronology on the marsh because of the much larger sample obtained. I estimated mean dates of nest initiation for each species by backdating class I broods seen throughout the lease. Thirty-five days were used as the average interval between nest initiation and hatching. Mean dates of nest initiation for Mallards, Canvasbacks, and Goldeneyes were during the third week in May; for Redheads, Buffleheads, and Widgeons during the last week in May; and for Blue-wings, Ring-necks, and Scaups during the first week in June. Average dates for Ruddy Duck and White-winged Scoter nests were in mid-June.

Weekly variation in beginning of nesting differed little between years for Scaups and Canvasbacks, but Ring-necks peaked one week earlier in 1963 than

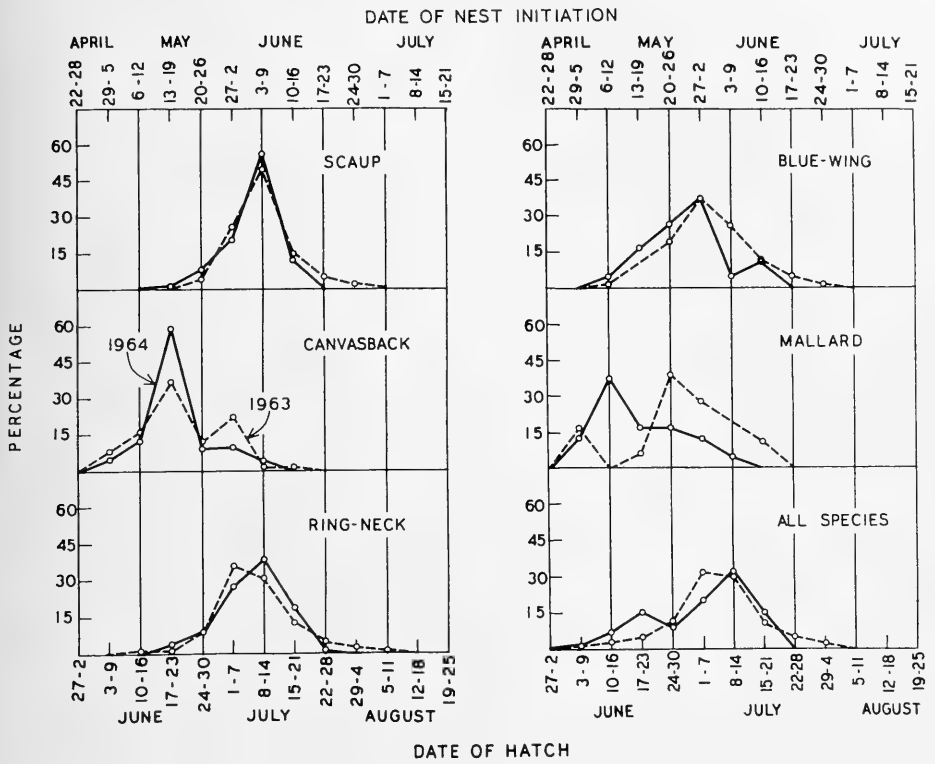

FIGURE 4. Distribution of successful nests of 5 species according to time of both initiation and hatching, as determined from backdating broods. Brood numbers include 438 Scaup, 163 Canvasback, 387 Ring-neck, 145 Blue-wing, 42 Mallard, and 1,481 all species.

in 1964 (Figure 4). Blue-wing brood numbers in 1964 were small, as were those of the Mallard in both years, and this probably accounts for the observed differences between years.

Figure 4 also presents the percentage of successful hens of all species beginning to nest each week. Selecting a date to start maintaining constant water levels can thus be done with a knowledge of what fraction of the nesting population will be affected. At least 4 per cent of the nests were started by 12 May 1963, and 8 per cent by this date in 1964. The percentage of nests being started increased rapidly thereafter, and any subsequent water-level manipulation might have affected a substantial portion of the nesting population.

Average Hatching Dates

The 1963-64 mean dates of hatch determined from nest data were: for 57 Scaup, 5 July ± 2 days; for 37 Ring-neck, 2 July ± 2; and for 13 Blue-wing, 30 June ± 5 days. Evidence from brood data indicates that the peak hatch occurred during the first week of July in 1963, and during the second week of July in 1964 (Figure 4). Mean dates of hatch for all species, determined from brood

data, were 7 July ± 1 and 4 July ± 1, for a 2-year average of 6 July ± 1. Ninety-two per cent of the successful nests were completed by 22 July 1963, and 99 per cent by the same date in 1964 (Figure 4).

Mean hatching dates determined from 438 Scaup, 387 Ring-neck, and 145 Blue-wing broods (10 July ± 1, 9 July ± 1, and 7 July ± 1 respectively) averaged 5-7 days later than those indicated by nest records. This difference could be due to a bias in the brood backdating procedure; or, since brood counts apply to the entire marsh, it could be that a slightly higher nesting success on Egg Lake tended to advance the mean date of hatch here. Since Egg Lake has more mammal-free islands than most of the other lakes on the marsh, I believe the latter explanation is more plausible. Mean dates of hatch for 163 Canvasback, 42 Mallard, 79 Goldeneye, and 99 Ruddy Duck broods were 22 June ± 1, 22 June ± 4, 23 June ± 2, and 15 July ± 1 respectively.

General Nest Data

Nesting Cover and Nest Densities

The percentages of each cover type searched on the islands and mainland were estimated by eye. They included approximately 45 per cent sedge, 40 per cent sedge-willow, 10 per cent sedge-cattail, and 5 per cent phragmites, with smaller amounts of cattail, cattail-phragmites, sedge-phragmites, and bulrush cover. Nesting Scaups, Ring-necks and Blue-wings tended to select the sedge habitat, while the Mallards seemed to prefer the sedge-willow complex (Table 1). Canvasbacks utilized phragmites over the other types.

Average densities of nests found in 1963 and 1964 were 0.45 and 0.73 nests per acre respectively, with a 2-year average of 0.59. Intensity of searching was greater in 1964 than in 1963, and this probably accounts for the difference between years. These figures represent minimum densities for the study area, because the procedure for locating nests relied mainly on flushing the hens, and undoubtedly some nests were missed. Nest densities on the islands averaged 0.82 nest per acre, while those on the mainland were 0.47. Densities were highest in the sedge cover, 1.0 nest per acre, and lowest in phragmites, 0.2 nest per acre (Table 1).

Clutch Size

Clutch sizes were determined for 203 nests in which laying was known to be completed. Blue-winged Teal had the highest average clutch size with 9.8 ± 0.4, while Canvasbacks had the lowest with 7.2 ± 0.9. Scaups had slightly larger clutches than Ring-neck, 9.0 ± 0.3 vs. 8.4 ± 0.4. Sample sizes were 25, 14, 84, and 46 respectively.

Average clutch size of Scaup decreased as the nesting season progressed. The simple correlation coefficient between clutch size (Y) and date of nest initiation (X) was −0.526 (66 nests), and highly significant from zero, while the simple regression coefficient was −0.097, also highly significant. Thus for every 10.3 days during the nesting season, the average clutch size of Lesser Scaup decreased by one egg. Although the Blue-wing and Ring-neck clutch

TABLE 1. — Nest densities and percentages of nests in major cover types. Only nests found by systematic searching are included.

Cover type	Acres searched	Mean nests/ year	Nests/ acre	Percentages of nests in each cover type				
				Scaup (88)	Ring-neck (48)	Canvas-back (15)	Blue-wing (31)	Mallard (12)
Sedge	71.5	72	1.0	77%	79%	7%	80%	25%
Sedge-willow	68.7	17	0.3	8%	4%	0%	13%	50%
Sedge-cattail	14.8	9	0.6	8%	15%	7%	7%	17%
Phragmites	9.8	2	0.2	2%	0%	47%	0%	0%

sizes also declined during the nesting period, the changes were not statistically significant, probably due to insufficient sample size.

The average number of eggs hatching in 55 Scaup, 37 Ring-neck, and 13 Blue-wing nests was 8.7 ± 0.4, 8.4 ± 0.4, and 9.2 ± 1.0 respectively. This represents an average decrease from the completed clutch size of 0.3 egg per nest for Scaups, 0 for Ring-necks, and 0.8 for Blue-wings. Out of 1,131 eggs laid in successful nests of all species, 51 (4.5 per cent) failed to hatch because of death of the embryo, infertility, etc. This compares with a loss of 7.3 per cent found by Keith in Alberta and 9 per cent for eight previous studies (Keith, 1961).

NESTING SUCCESS

Biases Attributed to Presence of the Investigator

Nesting studies are often criticized because of the possible influence of the investigator on the predation and/or desertion rate. Trails made by the investigator to nests, nest markers, increased desertions, and defecation by flushing hens have all been cited as introduced effects that increase predation (Hammond and Forward, 1956). In an effort to reduce these effects, I attempted to approach each nest from a different direction during each visit, and kept the number of visits to a minimum. Visible nest markers consisted of a clump of dead grass tied to a willow nearby. The markers resembled those used by local Indians in marking muskrat traps and are seen frequently on the marsh. If a bird defecated on a nest when flushed, I washed the nest and eggs by sprinkling water over them, and I covered all nests with nest material upon leaving.

To determine whether or not defecting on the nest by the hen, and subsequent washing of the nest and contents by me, had any significant effect on the predation rate, I recorded whether or not a bird defecated when flushed. In 196 first visits, 30 per cent of the hens defecated when flushed from the nest. After a period of from 7 to 10 days, each nest was revisited, and its fate noted. Twelve per cent of 58 nests on which hens defecated during first visit were destroyed. Twenty per cent of 138 nests not defecated on were destroyed.

TABLE 2. — Summary of fate of nests in 1963 and 1964.

Site	Deserted	Predation			Hatched	Total
		Mammal	Avian	Unknown		
Mainland	2	14	7	28	62	113
Island	3	1	6	5	70	85
Total	5	15	13	33	132	198

A Chi-square test yields no significant difference between the two groups. Due to the flooded conditions of the study area, reducing the possibility of lingering human scent, I suspect that the presence of persons searching for nests had very little effect on the predation rate.

Computing Nesting Success

Nesting success was computed by two methods. The customary method, whereby the number of successful nests is divided by total nests of known fate, was used because it provides a basis of comparison with previous nesting studies. Another procedure, developed by Mayfield (1961), was also used, because it takes into account the previously uncorrected bias resulting from incomplete nest history. Briefly, this procedure expresses nest success in terms of a daily survival rate, calculated by dividing total unsuccessful nests by the total number of nest days of observation. The probability of a nest surviving the entire period of laying and incubation is the daily survival rate (1 — mortality rate) raised to a power representing the number of days required for egg laying and incubation. To use this procedure, one must assume a constant survival rate throughout the nesting period of 35 days.

Fate of Nests, Islands vs. Mainland

Thirty-one per cent of 198 nests were destroyed by predators, and 3 per cent were deserted. Less than half of the predators could be identified with reasonable assurance as being mammalian or avian. Of these, mammalian predators destroyed two-thirds of the mainland nests, but only one on the islands (Table 2). Major predators on islands were Crows (*Corvus brachyrhynchos*) and Ravens (*C. corax*), while probable predators on the mainland included foxes (*Vulpes vulpes*), weasels (*Mustela* spp.), coyotes (*Canis latrans*), and possibly skunks (*Mephitis mephitis*) and mink (*Mustela vison*).

There was no reason to suspect that avian predation on islands was different to that on the mainland. Nest loss on the mainland was 63 per cent, and that on the islands was 27 per cent, and the difference of 36 per cent represents the probable amount of predation caused by mammalian species not reaching the islands.

Nesting Success by Species

Overall nesting success for 1963 was 70 ± 10 per cent, calculated by the standard method, or 58 per cent, calculated by Mayfield's procedure (Table 3).

TABLE 3. — Overall nesting success of major species in 1963 and 1964. Confidence limits on percent success are at the 95% level, and numbers of nests are in parentheses.

Species	1963		1964	
	Percent success	Mayfield percent success	Percent success	Mayfield percent success
Lesser Scaup	73 ± 16 (33)	62 (35)	64 ± 14 (50)	47 (54)
Ring-necked Duck	88 ± 17 (17)	83 (18)	76 ± 16 (29)	60 (31)
Canvasback	100 (3)	100 (3)	100 (5)	100 (12)
Blue-winged Teal	42 ± 31 (12)	20 (16)	60 ± 27 (15)	36 (16)
Mallard	67 (3)	46 (3)	56 ± 38 (9)	37 (10)
Total	70 ± 10 (76)	58 (84)	65 ± 8 (122)	47 (141)

Nesting success in 1964 was 65 ± 8 per cent and 47 per cent respectively. Success by species is presented in Table 4.

Keith (1961) reported 20 per cent success for 115 Scaup nests in parkland habitat. Rogers (1964) found Scaup nesting success very low on prairie potholes, and he attributed this partly to increased predation during years of low water. Ring-neck success in floating-sedge habitat in Maine was 69 ± 4 per cent, almost equal to that found in this study (Mendall, 1958). Scaup and Ring-neck seemingly are more successful nesting in flooded or floating sedge.

Blue-wing nesting success in the present study was considerably lower than that of Scaup and Ring-neck, and comparable to success found in the parklands (48 per cent in 84 nests) (Keith, 1961), and in prairie potholes (32 per cent in 192 nests) (Stoudt *et al.*, 1953, 1954, 1955, 1956). Blue-winged Teal, however, tended to select the drier sedge habitat, which resembles somewhat the moist meadows or hayfields surrounding potholes and parkland impoundments.

TABLE 4. — Mainland and island nesting success of major species during 1963-64. Confidence limits on standard method are at the 95% level, and numbers of nests are in parentheses

Species or group	Mainland nesting success		Island nesting success		Overall nesting success	
	Standard method	Mayfield method	Standard method	Mayfield method	Standard method	Mayfield method
Lesser Scaup	55 ± 16 (40)	37 (45)	79 ± 12(43)	70(44)	67 ± 10 (83)	53 (89)
Ring-necked Duck	76 ± 15 (33)	63 (35)	92 ± 16(13)	86(14)	80 ± 12 (46)	69 (49)
Canvasback	— (0)	— (2)	100 (8)	100(13)	100 (8)	100 (15)
Blue-winged Teal	42 ± 24 (19)	17 (23)	75 ± 36 (8)	60 (9)	52 ± 20 (27)	28 (32)
Mallard	28 ± 42 (7)	15 (8)	100 (5)	100 (5)	58 ± 31 (12)	39 (13)
All divers	60 ± 11 (79)	42 (83)	82 ± 9(69)	88(75)	70 ± 7(148)	56(158)
All dabblers	44 ± 17 (34)	24 (39)	81 ± 21(16)	67(18)	56 ± 14 (50)	35 (57)
All species	55 ± 9(113)	37(122)	82 ± 8(85)	73(93)	67 ± 7(198)	51(215)

TABLE 5. — Number of nests by species in each site classification, 1963-64. Canvasback total includes two nests found in emergent vegetation.

Species	Site classification			Total
	Floating	Semi-floating	Solid	
Lesser Scaup	42	25	12	79
Ring-necked Duck	21	12	13	46
Blue-winged Teal	5	7	17	29
Mallard	3	1	5	9
Canvasback	3	0	6	11
Miscellaneous species	9	7	7	23
Total	83	52	60	197

Nesting Success Related to Site Classification and Distance to Water

The floating-sedge mats used by nesting Scaups, Ring-necks, and even Blue-wings were typically riddled with small channels and openings that apparently provided excellent interspersion of nesting cover and water. Fifty-three per cent of the Scaup nests, 46 per cent Ring-neck nests, and 17 per cent of the Blue-wing nests were found in this site type (Table 5). Where the ground was solid or semisolid, water often lay in the depressions between sedge hummocks, and scarcely a square yard of cover existed without some water on it. Only in the center of a few of the large islands, and back from the lakeshore 50-100 yards, did moist rather than flooded sedge meadow exist.

Forty-seven per cent of 77 nests were found on quaking sites in 1963, while 84 per cent of 118 nests were discovered here in 1964. Lake levels, however, were approximately 3-4 inches higher in 1964 (Figure 2). This suggests that the ducks chose to nest in the same area in both years, even though the area was somewhat wetter in 1964.

I made two measurements of nest distances from water, *i.e.*, to the nearest large body of water, usually the lake itself, or an opening greater in area than 50 x 50 feet; and to the closest water, such as a small channel, or flooded sedge. In distance to large water, the Canvasback nested closest, followed in order by the Scaup, Ring-neck, Blue-wing, and the Mallard (Figure 5).

The mean distance of all nests from large water was 74 $\pm$ 12 feet. Successful nests averaged 64 $\pm$ 13 feet from water, and unsuccessful nests averaged 82 $\pm$ 24 feet. Apparently nests closest to the lakeshore suffered less predation. It appears from a species breakdown (Table 6) that predation falls heaviest on dabblers because they are more reluctant to nest in extremely wet sites close to water than are divers.

Canvasback, Ring-neck, and Scaup nests averaged 1-2 feet from nearest water, while Mallard and Blue-wing nests averaged 6 $\pm$ 5 and 17 $\pm$ 10 feet respectively. Mean distances from nearest water were smaller in 1964 than in 1963, probably due to the difference in water levels previously mentioned.

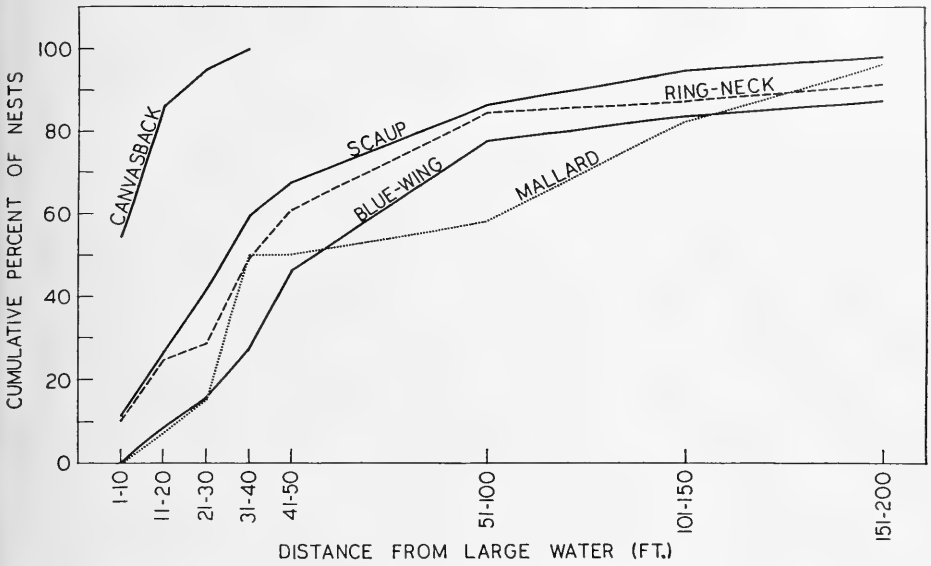

FIGURE 5. Distribution of nests of 5 species from large bodies of water (greater than 50 x 50 feet). Sample sizes include 15 Canvasback, 85 Scaup, 49 Ring-neck, 32 Blue-wing, and 12 Mallard nests.

All nests averaged 5.0 ± 2.0 feet from nearest water, with successful nests at 2.3 ± 0.7 feet, and unsuccessful nests at 10.0 ± 5.5 feet. Once again there was the indication that nests closest to water, *i.e.*, on the wettest sites, were more successful.

Keith (1961) found the opposite relationship, predation being the highest along the *Juncus* zone closest to water. However, closeness to water in his prairie pothole study referred to a moist-soil condition, which presumably made odors easier to detect. I suspect the primary reason for less predation close to water in the present study was that the floating-mat conditions deterred foxes, coyotes, and skunks from consistently hunting in these areas.

Nesting Success Related to Cover Types

Two morphologically different groups of sedges were found on Egg Lake, *i.e.*, the "needle-leafed" sedges, consisting of *Carex lanuginosa* and *C. diandra;* and the "broad-leafed" sedges, *C. lacustris*, *C. aquatilis*, *C. atherodes* and *C. rostrata.* The data, upon examination, showed no significant difference in hatching success between the groups, and the two cover types were thus combined into one — the sedge zone. Another major cover type, the sedge-willow zone, included sedges as understory with interspersed low willow species, *Salix candida*, and *S. pedicellaris*, as dominants.

Nests in the sedge zone experienced a lower predation rate (32 ± 8 per cent in 131 nests) than did those in the sedge-willow complex (57 ± 18 per cent in 30 nests). The mean distance of nests from large water in the sedge zone was

80 ± 14 feet, while that for the sedge-willow zone was 140 ± 127 feet. I suspect the predation rate was more a function of wetness of habitat than cover type per se — the sedge zone being adjacent to open water, and the sedge-willow zone farther inland.

MANAGEMENT

The aim of this section is to make recommendations for increasing waterfowl productivity in habitats comparable to the one involved in the present study. The data can be used in formulating a water-level management plan involving multiple interests.

Water Levels During Nesting

At least 5 per cent of all ducks had begun nesting by 12 May. There is very little time between ice breakup at the end of April and the beginning of waterfowl nesting in which to raise or lower water levels without threatening nests of the Mallard and Canvasback in particular. Toward the end of the nesting season, approximately 95 per cent of successful nests were completed by 20 July. Species most vulnerable to loss of nests at this time are the Ruddy Duck and the White-winged Scoter. Water levels should not be changed before this date.

Species differences in requirements for nesting must be considered when establishing optimum levels to hold water. I found a significant shift in the species composition of brood counts between 1962 and 1963 on lakes that had markedly lower water levels in 1963 (Townsend, unpublished data). The percentage of dabblers in total brood counts increased in 1963 on lakes which had lower water levels that year, while there was no significant change in brood percentages on those lakes that had no water level changes. Unfortunately, part of the differences observed could be due to a change in species observability of broods associated with lower water levels; the magnitude of this bias remains unknown. If the differences were real, then the question arises whether or not they reflect a decline in diver production, an increase in dabbler production, or combination of both, under low-water conditions.

Since the nest data indicate higher success for nests closer to water, perhaps higher water levels would increase nest success by causing nests to be situated closer to water. When water levels are increased, the floating-mat vegetation surrounding many of the lakes merely floats higher. Toward drier ground the water may flood vegetation where it is anchored solidly to the bottom, but this ring of flooded sedge or sedge-willow would probably act as a deterrent to mammal predators attempting to reach the floating zone. Holding water high would probably benefit divers more than dabblers, although dabblers also make use of floating sites for nesting (Table 5).

On lakes where nesting cover is adequate and much of the immediate shoreline tends to be floating, I recommend holding the water high. Where the shoreline is not floating, and increased emergent vegetation is desired, water levels should be held lower. This can be accomplished largely by control structures between lakes.

Increasing Nesting Success

The present study indicates that nesting success on this small portion of the Saskatchewan delta is as high or higher than average success reported for the prairies. Nevertheless, a substantial percentage of nests are lost each year to predation. In view of the extremely high nesting success observed on islands, creating more nesting islands in impoundments of this type might be one way to increase production. The irregularity of lake shorelines could be used to advantage, by converting peninsulas into islands through channel blasting. Another way of creating islands would be to raise the water levels of lakes that have floating shorelines, thereby creating a strip of flooded shore around the lake separating the floating cover from the mainland.

SUMMARY

A total of 225 duck nests were studied during 1963 and 1964 in floating-sedge habitat on the Saskatchewan River delta. Clutch sizes averaged 9.0 ± 0.3 for Lesser Scaup, 8.4 ± 0.4 for Ring-necked Duck, 7.2 ± 0.9 for Canvasback, and 9.8 ± 0.4 for Blue-winged Teal. Mean dates of nest initiation and hatching were determined from nests and backdating 1,481 class I broods. Mean dates of nest initiation for Mallards, Canvasbacks, and Common Goldeneyes occurred during the third week in May; for Redheads, Buffleheads, and Widgeons during the last week in May; and for Blue-wings, Ringnecks, and Scaups during the first week in June. Peak hatches occurred during the first week of July in 1963 and the second week of July in 1964. A significant decrease in clutch size of one egg for every 10.3 days' delay in nesting was observed for Scaup. Island nest densities averaged 0.82 nest per acre while mainland densities were 0.47 nest per acre. Overall nesting success was 70 ± 10 per cent in 1963 and 65 ± 8 per cent in 1964. Mayfield's procedure of computing nesting success reduced these figures to 58 per cent and 47 per cent respectively. Island nesting success averaged 82 ± 8 per cent, while that on the mainland was 55 ± 9 per cent. Success was highest among nests closest to water. Recommendations for improving nesting success include the construction of small nesting islands out of peninsulas and raising water levels to deter foxes and other mammals from reaching floating shorelines.

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THE ABUNDANCE OF LEMMINGS AT ABERDEEN LAKE, DISTRICT OF KEEWATIN, 1959-63

A. H. Macpherson
Canadian Wildlife Service, Ottawa

Objective

A recent study by the Canadian Wildlife Service at Aberdeen Lake (64° 37′ N., 99° 43′ W.), District of Keewatin, Northwest Territories (Figure 1), of the factors controlling the abundance and harvests of the arctic fox (*Alopex lagopus*), included regular assessment of the lemming population near base camp by means of a line of snap-traps. The indices of lemming abundance so obtained between 1960 and 1963 are here presented and discussed, with some supplementary field notes.

Method

Although no trapping was done, it was observed on a visit to the study area in 1959 that lemmings were very scarce. In 1960, camp was established at Aberdeen Lake in May, and in early June, a prefabricated building was erected as a base for the study. In mid-June, a line of twenty snap-traps was laid, at lemming sign, in a roughly circular course of about one and a half miles, with the cabin near the circumference. The traps were left out over the next three years, but were baited (with raisins) and set only for two-day periods in mid-June and mid-July. Lemming specimens caught in 1960, 1961 and 1963 were deposited in the collections of the National Museum of Canada, those of 1961 by my wife, Elizabeth Macpherson. The 1962 collection was sent to the University Zoological Museum, Oslo, Norway. The traps were positioned so as to sample the sedge meadows favoured by the brown lemming *Lemmus sibiricus* (=*trimucronatus*), the dry ridges inhabited by the varying lemming *Dicrostonyx torquatus* (= *groenlandicus*) and a variety of intermediate habitats. The animals caught, plus identifiable set-offs, were recorded. In June 1960, the 40 trap-nights yielded 14 *Dicrostonyx* and nine *Lemmus*: these catches were arbitrarily given index values of 100, and subsequent catches were given percentage values of the first catches.

Each time the traps were reset, fewer appeared to be in "good" locations, close to signs of lemming activity. At the same time, previously unnoticed lemming sign was seen at places on the line where no traps had been set. It appeared probable that, if the traps had been placed anew each year at fresh sign, larger catches would have resulted in the years since the year in which the line was first established. An effort was made in 1963 to estimate the extent of the loss in efficiency that was believed to have occurred. A new line of 20 traps was set at lemming sign in an area similar to that of the first, or standard trap line, and centred about a quarter of a mile from it. A two-day trapping period produced a slightly higher catch of both species in this new area than in the first. I took this result to mean that the standard line was not catching as many lemmings as it would have done had it been reset in similar habitat, but

TABLE 1. — Adjusted lemming population indices, Aberdeen Lake standard trap line (see text).

Year	*Dicrostonyx*		*Lemmus*		Combined	
	June	July	June	July	June	July
1960	100	100	100	44	100	72
1961	121	81	24	13	74	48
1962	12	19	41	7	26	13
1963	36	43	33	11	34	27

at fresh sign, each year. The loss in efficiency was assumed to have been progressive since 1960, and cumulative yearly increments were added to the indices of 1961, 1962 and 1963, of 2.3 units for *Dicrostonyx*, 3.7 for *Lemmus*, and 2.9 for the combined lemming index (Table 1). Only adjusted indices are given in this paper.

The differences observed, and for which adjustments to the indices were made, may have, of course, been due merely to chance variation about the mean. In fact, the increments added were so small as to make very little difference to the results.

STUDY AREA

Brown and varying lemmings occupy different habitats on the central arctic tundra. In summer, the brown lemming is typically an inhabitant of sedge meadows, particularly of wet cotton-grass lowlands, and the varying lemming of the dryer, more barren uplands. The relative number of each species caught on a trap-line is therefore dependent to a great extent on the proportion of wet and dry habitats on its course. Some description is therefore required of the study area and its vegetation.

The area trapped lies at the west end of Aberdeen Lake, and is underlain by more or less flat-bedded Dubawnt Sandstone, Precambrian in age, but so generally covered with till and debris that only the occasional frost-heaved slab is visible on the surface. The former glaciation of the area is indicated by numerous eskers and related depositional features, as well as by fluted moraines. The country is low and rolling on the north side of the lake, with emerged strand features dating from a period of post-glacial marine transgression. On the south shore, the land rises gently to some 800 feet above the lake, and shows bold terraces, evidence of deep proglacial lakes. As might be expected from its geomorphic history (Bird, 1951), the sandstone has been much weathered and redeposited as lacustrine and alluvial plains or terraces.

In walking over the study area, one crosses a succession of low, rounded rises and intervening gentle dips. The rises display prominent wind blow-outs, often associated with caribou trails, and are characteristically surfaced with pebbles, cobbles and coarse sand. The vegetation of nearby, similar areas has

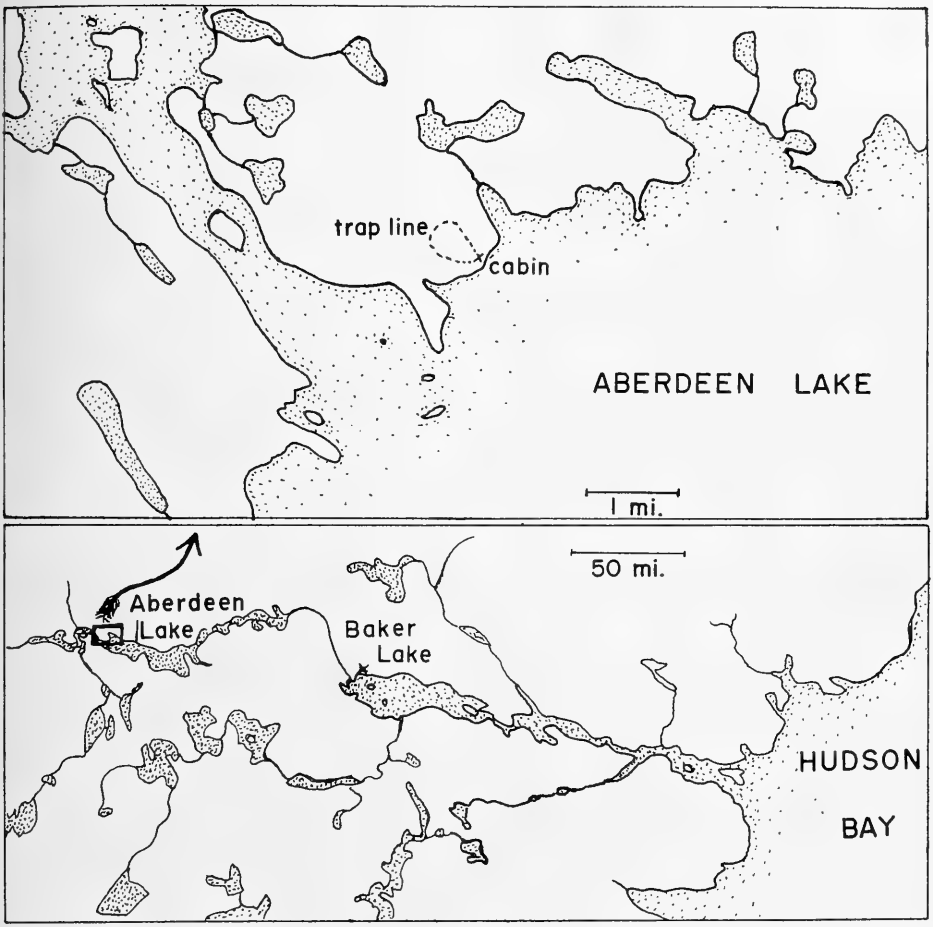

FIGURE 1. The location of the standard trap line at Aberdeen Lake (top) in the District of Keewatin, Northwest Territories (bottom).

been described by Kelsall and Loughrey (Kelsall, 1960) and by Krebs (1964). In well-drained places, it is often very sparse, being limited to a few clumps of grass and cushion plants. Elsewhere, the ridges may be densely clothed in black, crinkly lichen (*Alectoria*) which itself may cover a continuous layer of sphagnum moss, broken here and there by clumps of grass, or by mud-boils supporting tenacious birch or rhododendron plants. The dips are occupied typically by wet cotton grass and sedge meadows, often tussocked. Other common components of the slope vegetation are berries such as bilberry and baked-apple. On the sides of the ridges, intermediate associations occur, and these, as well as most of the other associations, often include Labrador tea as a prominent component.

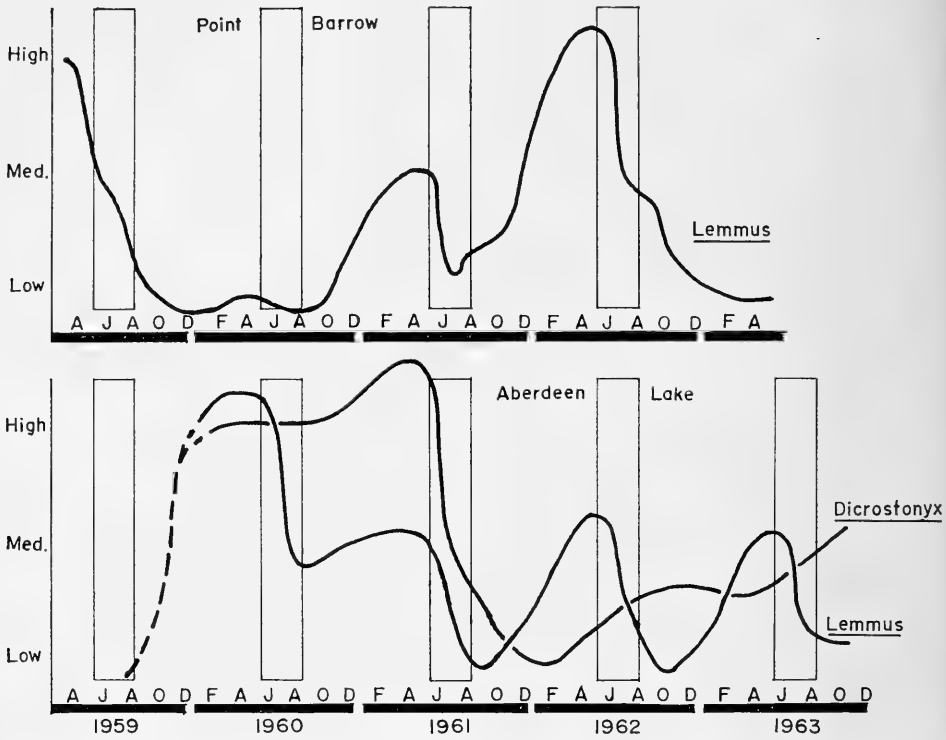

FIGURE 2. A hypothetical curve of changes in the number of trappable lemmings (*Dicrostonyx* and *Lemmus*) at the northwest corner of Aberdeen Lake, 1959-1963, based on adjusted snap-trap indices (see Table 1). The indices are shown as "x's". For comparison, the relative abundance of the two species, according to Krebs (1963), 115 miles to the east at Baker Lake, is shown by an "L" for *Lemmus* and a "D" for *Dicrostonyx*.

LEMMING NUMBERS

Table 1 and Figure 2 show the lemming indices obtained: in the figure they are joined by curves representing the supposed relative population size for the intervals between trapping periods. Figure 2 also includes an estimate of lemming numbers in 1959, based entirely on casual observations made near the study area. The relative abundance of lemmings in the latter half of July at Aberdeen Lake and Baker Lake, as estimated on the basis of intensive studies by Krebs (1963 and 1964, and *in litt.*) is shown in Table 2.

Differences between the two sets of indices for Aberdeen Lake exist in part because those of Krebs are based on a July trapping period, whereas mine are means of June and July trapping periods. As might be expected, Krebs' indices compare better with the July figures from Table 1 alone. His figures were based on a much larger number of trap nights (645 in 1960 to 2,226 in 1962), but are perhaps less directly comparable from year to year. The productivity of the two sets of trap lines also differed greatly. Krebs' traps were set according to a standard grid pattern, and caught their maximum of 15 lemmings per

TABLE 2. — Comparison of estimates of lemming abundance at Baker Lake and Aberdeen Lake, 1959 to 1963. (1) Krebs (1963): relative density based mainly on live trapping, (2) Krebs (*in litt.*; also 1964): crude indices based on snap-trapping, (3) means of June and July indices from Table 1. All reduced to percentages of highest number in the series.

Year	Baker Lake		Aberdeen Lake			
	(1)		(2)		(3)	
	Lemmus	*Dicrostonyx*	*Lemmus*	*Dicrostonyx*	*Lemmus*	*Dicrostonyx*
1959	2	~7	–	–	–	–
1960	100	100	100	100	100	99
1961	7	21	59	55	26	100
1962	2	24	32	14	33	16
1963					31	40

100 trap nights in 1960. In the same year, mine caught lemmings at the rate of over 50 per 100 trap nights.

DISCUSSION

The synchrony between the population oscillations of the two lemmings is noteworthy, particularly in view of the differences in appearance and habitat between the two species. The synchrony is more pronounced in the Baker Lake data than in that from Aberdeen Lake, where *Dicrostonyx* apparently increased considerably in the winter of 1960-61, a period for which Krebs (1963) deduced a decrease at Baker Lake. It is also notable that the Baker Lake and Aberdeen Lake lemming oscillations were in phase, when one considers that only the most tenuous sort of continuity could be held to exist between the lemming populations of the two areas, separated by 115 miles of hills, boulder fields, lakes and rivers. According to verbal report, the cyclic high of 1960, at least, was synchronous over an even larger area, including Eskimo Point, some 300 miles southeast of the Aberdeen Lake base camp.

The pronounced downturn that lemming populations usually took during the summer months is in accord with the generalizations of Pitelka (1957), although, as Krebs (1963) has pointed out for Baker Lake, predation and destruction of cover are untenable explanations for this phenomenon in the District of Keewatin. The shape of the curve of population increase given by Pitelka (Figure 3), however, differs markedly from that obtained by snap-trapping at Aberdeen Lake, and also, apparently, from that based on Krebs' abundant data. The precipitous decline, followed by a rising curve interrupted by minor declines each summer, of the Barrow lemmings, is perhaps duplicated in the 1961-63 *Dicrostonyx* data from Aberdeen Lake, but not by the contemporary *Lemmus* indices. The 1959-1961 Keewatin *Lemmus* data, however, cannot be related to any part of the Point Barrow brown lemming curve, nor to the hypotheses of Lack (1954), Pitelka (1957) and Bee and Hall (1956), which invoke either critical predation or food shortage following degradation of the plant cover.

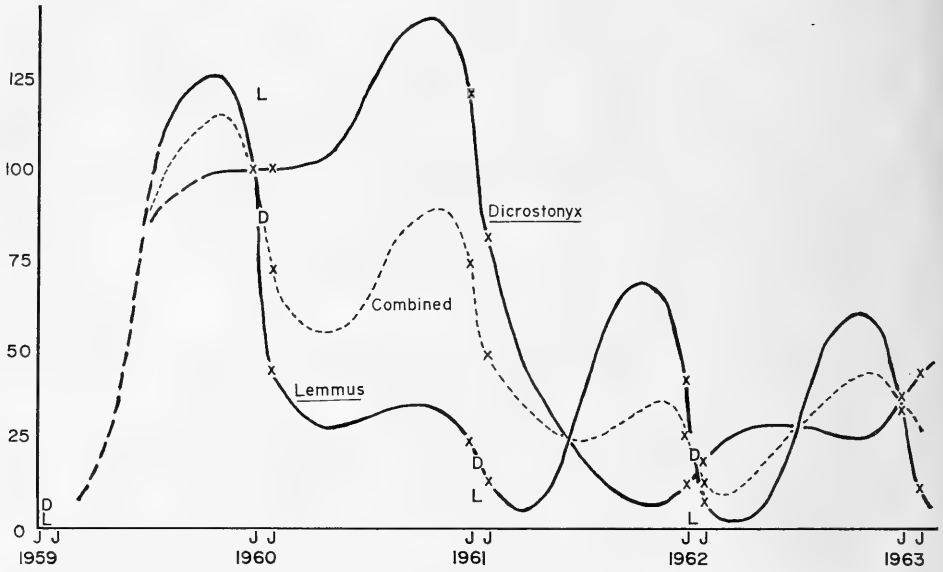

FIGURE 3. The curves from Figure 2 (bottom) compared with the generalized curve of Pitelka (1957) for the *Lemmus* cycle at Point Barrow, Alaska.

The recording of changes in the abundance of Aberdeen Lake lemmings, and their apparent synchrony between species and between places, is the main object of this report. Some comments on the shape of the curve constructed about the index points have also been made. For a study of the biological phenomena associated with Keewatin lemming cycles, and their possible causation, the reader is referred to Krebs (1963, 1964). For critical readings of this note in manuscript, I am indebted to Dr. C. J. Krebs of the University of Indiana, and to Dr. D. A. Munro, Mr. A. G. Loughrey and Mr. D. Eagles of the Canadian Wildlife Service.

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PROBOSCIDEAN MOLARS FROM MANITOBA

HARVEY R. YOUNG
Department of Geology, Brandon College, Brandon, Man.*

THE RECORD of mammoth remains in Manitoba has been summarized by Leith (1949). These remains consist of two tusk fragments and two teeth found in Pleistocene gravel deposits at the following locations (Figure 1);

1. A tusk fragment; from the south bank of the Swan River, 3½ miles north of the town of Benito.
2. A tusk fragment; in a gravel pit 4 miles east and 1 mile north of Transcona. Leith suggests the probable location of this find as Section 12, Township 11, Range 4, East of the Principal Meridian.
3. A milk tooth; in a kame or esker deposit at Birds Hill, northeast of Winnipeg. The exact location is unknown.
4. A molar tooth; in a gravel pit in the southeast quarter of Section 21, Township 9, Range 7, East of the Principal Meridian, five miles east of Dufresne.

Leith points out that the tusk fragments are short, poorly preserved and cannot be positively identified. However, he assigns the teeth to *Mammonteus primigenius*, noting that in some respects they resemble the molars of *Parelephas jeffersoni*.

To the above list may be added two more recent discoveries. In the spring of 1959 Mr. J. Pritchard of Rathwell, Manitoba, discovered a small molar tooth in a gravel pit in section 16, Township 9, Range 9, West of the Principal Meridian. The site is on the south bank of the Assiniboine River, approximately nine miles northeast of Rathwell. This specimen is now in the collection of the Manitoba Museum, Winnipeg.

The most recent find, from western Manitoba, occurred in October 1964 when Mr. H. Treloar of Rivers, Manitoba, discovered a large tooth in a gravel pit in the northeast quarter of Section 35, Township 11, Range 21 West of the Principal Meridian. The deposit in which the tooth was found consists of stratified and cross-bedded sands and gravel, with occasional thin clay beds. Klassen (1963) has mapped the adjacent area to the north of the gravel pit and indicates a minor meltwater channel trending through the site. Although the sand and gravel at the site are probably post-glacial and associated with this meltwater channel, they may represent late glacial (Wisconsin) or early post-glacial stream terrace deposits.

The tooth from the Rathwell location (Figures 2, 3 and 4), with the exception of the root talons, appears to be complete and little abraded. Its total length, measured at right angles to the ridge plates, is 95 mm. Maximum width is 36 mm and the height of the 9th ridge is 45 mm. The total number of ridge plates is 12, although the anterior and posterior ones are indistinct. The grind-

*Present Address: Department of Geological Sciences, Miller Hall, Queens University, Kingston, Ont.

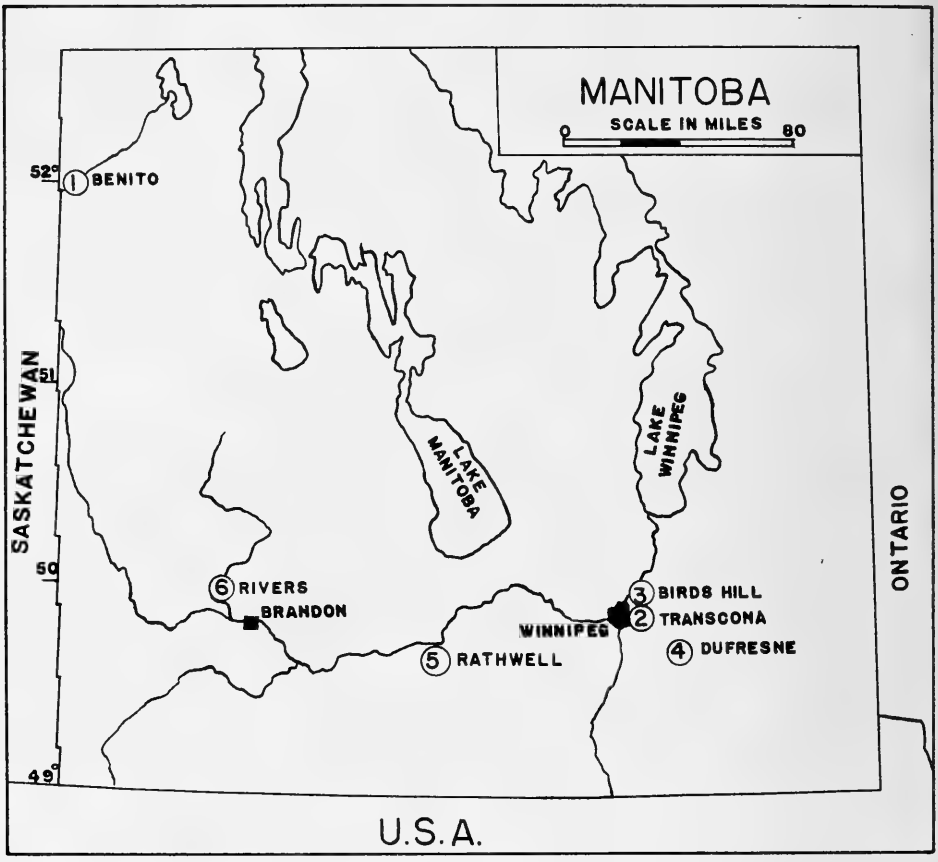
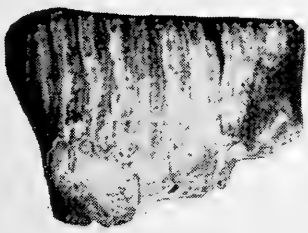


FIGURE 1. Locations of mammoth remains in Manitoba (see text).

ing surface is slightly concave and apparently all 12 plates were in use. Seven ridge plates occur in a distance of 50 mm, measurements being taken both at mid line and on the grinding surface at right angles to the plates. The ridge plates thus do not show any compression toward the summit but remain parallel to one another over their length. The size of this tooth, the number of plates and their compression suggests it probably represents a first molar of *Mammonteus primigenius*.

The tooth from the Rivers location has been abraded but various measurements indicate that it does not belong to *M. primigenius*. This tooth (Figures 5 and 6) measures 310 mm in length and consists of 20 nearly parallel ridge plates, with a maximum height of 200 mm as measured on the outside concave surface. The grinding surface is 200 mm in length, 90 mm in width and apparently 12 transverse ridge plates were in use. On the inside surface at the base of the tooth 5 ridge plates occur in a distance of 100 mm, while at mid line 6 plates occur in the same distance.



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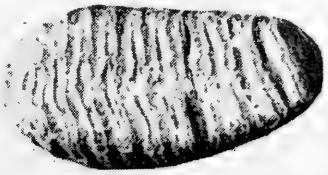

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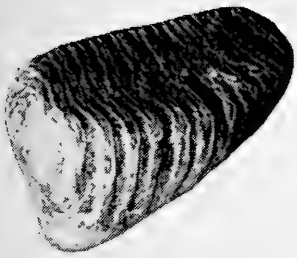

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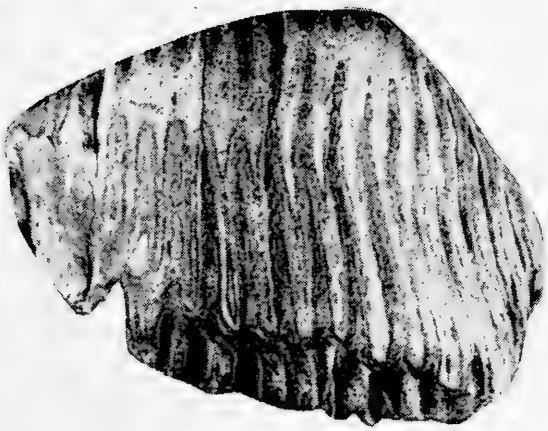

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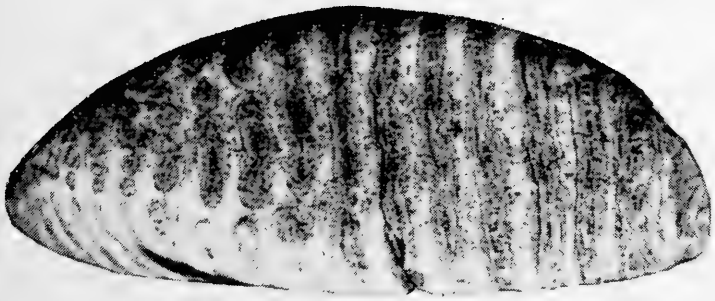

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FIGURES 2, 3 and 4; Side, crown and oblique views of first molar of *Mammonteus primigenius* ?, X 0.4

FIGURE 5. Side view of third molar of *Parelephas jeffersoni*, X 0.25

FIGURE 6. Crown view of third molar of *Parelephas jeffersoni*, X 0.4.

Dr. S. David Webb (personal communication) suggests that the Rivers tooth probably represents a third molar of *Parelephas jeffersoni*. It is possible that as a result of abrasion some of the anterior plates may be missing, yielding a lamellar count which is lower than normal for a third molar of *P. jeffersoni*. Also the ridge plate compression is too low for *M. primigenius* and rather high for *Archidiskodon imperator*, the Imperial mammoth.

Parelephas jeffersoni had widespread distribution throughout the northern and middle United States and southward to Mexico. This recent find extends its range northward into western Manitoba.

The writer would like to thank Mr. R. Sutton of the Manitoba Museum for his co-operation in making the Rathwell specimen available for study. Mr. Treloar kindly allowed examination of the Rivers specimen.

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SUMMER FOOD HABITS OF RED-TAILED HAWKS NEAR ROCHESTER, ALBERTA

E. C. MESLOW AND LLOYD B. KEITH
Department of Wildlife Ecology, University of Wisconsin, Madison

RAPTOR STUDIES WERE INITIATED near Rochester, Alberta, during the summer of 1965. This work complements our continuing investigations of the 10-year population cycle among snowshoe hares (*Lepus americanus*), grouse, and certain predators. From April to September, the Red-tailed Hawk (*Buteo jamaicensis*) is the commonest large raptor in this section of Alberta, having nesting densities of approximately one pair per square mile. The current report summarizes food habits of young Redtails as determined from prey remains in nests and pellets, and from collections of food items brought to

TABLE 1. — Food habits of nestling and fledgling Red-tailed Hawks from ten nests near Rochester, Alberta, summer 1965

Food species	No. of individuals	Percent occurrence	Approximate biomass in grams	Percent biomass
MAMMALS				
Richardson ground squirrel *Citellus richardsonii*	36	17.1	16,740	30.4
Snowshoe hare (adult) *Lepus americanus*	10	4.8	14,000	25.4
Pocket gopher *Thomomys talpoides*	15	7.1	1,800	3.3
Mice Cricetidae	58	27.6	870	1.6
Franklin ground squirrel *Citellus franklinii*	1	0.5	440	0.8
Least weasel *Mustela rixosa*	2	1.0	90	0.2
Short-tailed weasel *Mustela erminea*	1	0.5	75	0.1
Least chipmunk *Eutamias minimus*	1	0.5	47	0.1
Unidentified rodents (not mice)	8	3.8	–	–
BIRDS				
Magpie *Pica pica*	8	3.8	4,400	8.0
Ruffed grouse *Bonasa umbellus*	7	3.3	3,850	7.0
Domestic duck	1	0.5	3,000	5.5
Coot *Fulica americana*	3	1.4	2,025	3.7
Pintail (adult) *Anas acuta*	2	1.0	2,000	3.6
Unidentified grouse	3	1.4	1,650	3.0
Flicker *Colaptes auratus*	8	3.8	1,040	1.9
Cooper's Hawk *Accipiter cooperii*	2	1.0	940	1.7
Gray Partridge (adult) *Perdix perdix*	2	1.0	800	1.5
Common Crow *Corvus brachyrhynchos*	1	0.5	450	0.8
Blackbird Icteridae	5	2.4	300	0.5
Duckling	4	1.9	200	0.4
Blue Jay *Cyanocitta cristata*	2	1.0	160	0.3
Sora Rail *Porzana carolina*	1	0.5	80	0.1
Gray Partridge (chick) *Perdix perdix*	2	1.0	50	0.1
Unidentified bird	26	12.3	–	–
AMPHIBIANS				
Toad	1	0.5	35	0.1
TOTAL	210	100.2	55,042	100.1

tethered fledglings. Such items are probably representative of adult diets as well (Fitch et al., 1946).

Ten Red-tailed Hawk nests were located during July 4-17, with young about 4-5 weeks old. Two nests were in an area of nearly 90 percent cultivated or grazed farmland; the remaining eight nests were surrounded by approximately 50 percent farmland. When the young hawks were almost fledged, around 5 weeks of age, they were jessed and tethered beneath the nest tree (for technique see Errington, 1932). Fresh prey and pellets were collected every second day. These birds were released in late July and early August when the adults stopped feeding them.

Table 1 presents the combined analyses of food items from all sources; estimates of numbers of individuals are undoubtedly conservative, particularly for mice. The most impressive aspect of the Redtail's diet was the great diversity of prey taken. It was especially surprising to find the pocket gopher (*Thomomys talpoides*) well represented, since in five summers of field work at Rochester we have never seen this subterranean mammal above ground. Equally unexpected was the complete absence of the very common red squirrel (*Tamiasciurus hudsonicus*). Snowshoe hares comprised about 25 percent of the total recognizable biomass consumed, a remarkably high proportion considering their current scarcity. Both Cooper's Hawks were collected at the same nest site, and at least one of these birds was an adult.

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LANDLOCKED ATLANTIC SALMON (*Salmo salar* L.) IN THE TERRA NOVA RIVER SYSTEM, NEWFOUNDLAND

C. W. Andrews
Department of Biology Memorial University of Newfoundland, St. John's, Nfld.

Introduction

A survey of the Terra Nova River and its tributaries was made by the author during June, July and August of 1952. The principal objective of the survey, conducted by canoe for the most part, was to furnish a report on obstructions to ascending sea-run Atlantic salmon (*Salmo salar* L.) and in a general way to report on the extent of spawning grounds suitable for this species. The results of the survey form the substance of reports already submitted to the Biological Station of the Fisheries Research Board of Canada, St. John's, Newfoundland.

During the course of the survey opportunity was afforded to collect data on landlocked Atlantic salmon (*Salmo salar* L.) commonly called ouananiche. The waters of the Terra Nova River system abound with this species especially in the area above Terra Nova Fall (Figure 1). This paper attempts to record growth characteristics, especially length and age relationships of the data thus obtained.

At the time of this survey no fish-way was in operation on the Terra Nova River and hence previous to the summer of 1952 no sea-run Atlantic salmon had penetrated the waters above the Fall which is about one mile below the town of Terra Nova. A modern fish-way was under construction at that time and it began operation during the late fall of 1952.

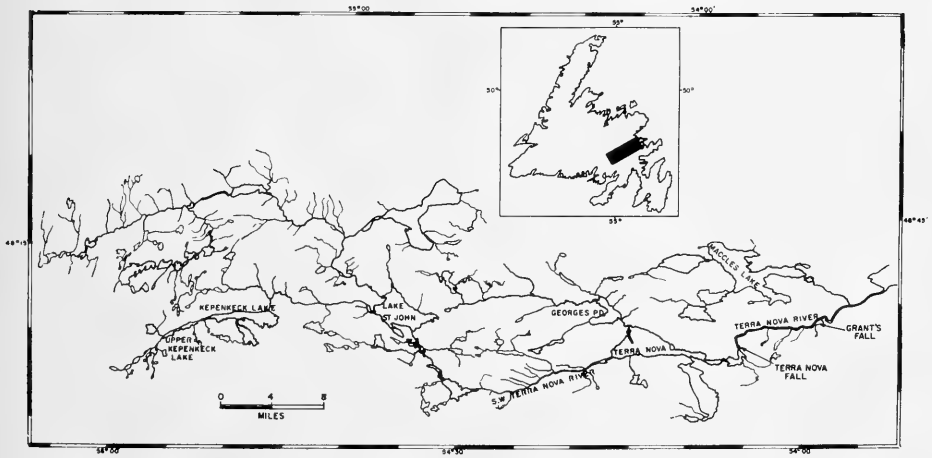

Figure 1. Map of the Terra Nova River System showing locations mentioned in the text.

FIGURE 2. Outlet of Kepenkeck Lake where ouananiche were plentiful, June, 1952.

TABLE 1. — Station list and number of fish collected at each station on the Terra Nova River system. Summer, 1952.

Station	Number of fish
1. Terra Nova Lake	64
2. Terra Nova River at Lake St. John Dam	66
3. George's Pond	32
4. South West Terra Nova River	3
5. Maccle's Lake	17
6. Kepenkeck Lake	41
7. Upper Kepenkeck Lake	8
TOTAL	231

MATERIALS AND METHODS

A total of 231 fish were collected from several stations on the Terra Nova River system as listed in Table 1. The locations of all points listed are shown in Figure 1. The fish were collected by means of gill nets, fyke nets, angling and the use of a small handseine which measured about 3 ft. x 3 ft., leaded along the footrope, and equipped with two wooden handles. One of the most successful angling locations was at the outlet of Kepenkek Lake (Figure 2) where 41 fish ranging in size from 9.9 cm. to 29.8 cm. were angled during one

FIGURE 3. Scales from landlocked salmon, Terra Nova River; left 2 + year-old, right 3 + year-old.

Table 2. — Age-length relationship of landlocked salmon in the Terra Nova River system. Summer, 1952. Figures in parentheses indicate number of fish in each age group.

Age (years)	Length (cm.)	Calculated length (cm.) $Y = 4.5X + 2.4$
1	9.9(1)	6.9
2	11.3(27)	11.4
3	17.6(44)	15.9
4	21.7(44)	20.4
5	25.0(57)	24.9
6	28.1(24)	29.4
7	32.0(12)	33.9
8	38.5(4)	38.4
9	38.2(3)	42.9

half hour at sunset on June 22, 1952. The dam site at Lake St. John was another very successful angling location.

Measurements are given as fork lengths to the nearest millimeter and ages were determined by the scale method. Typical scales taken from the area between the lateral line and the adipose fin, are shown in Figure 3. The scales were preserved in blotting paper, removed in the laboratory and washed; they were then mounted on glass slides and read using a standard microprojector.

RESULTS

Length distribution

The ouananiche ranged in size from 6.5 to 48.5 cm. (Figure 4) with a modal length of 24.5 cm. Included in the modal length-group were 42 fish or 25.4 per cent of the sample. Absence of fish smaller than 6.5 cm. is attributed to the collecting technique where fish smaller than 6.5 cm. could pass through the meshes of the nets used or they were too small to angle. The largest fish (48.5 cm.) was taken by gill net in Terra Nova Lake and a second ouananiche measuring 40.8 cm. was also taken by gill net in Terra Nova Lake. Scott and Crossman (1964) report the largest ouananiche taken in their sample in Lake St. John, Newfoundland, at 48.1 cm., fork length, with a live weight of approximately 2½ pounds. The largest fish taken in Lake St. John in our sample was 37.5 cm.

Age frequency

Ages ranged from 1 + to 9 + years with the modal age at 4 + years as shown in Figure 5; 66 fish or 27.5 per cent of the sample were contained within this modal group. The mean age of the total sample was 4.4 years.

Age-length relationship

Mean lengths for each age-group are shown in Table 2 and Figure 6. Growth demonstrates a straight line relationship

$$Y = aX + b$$

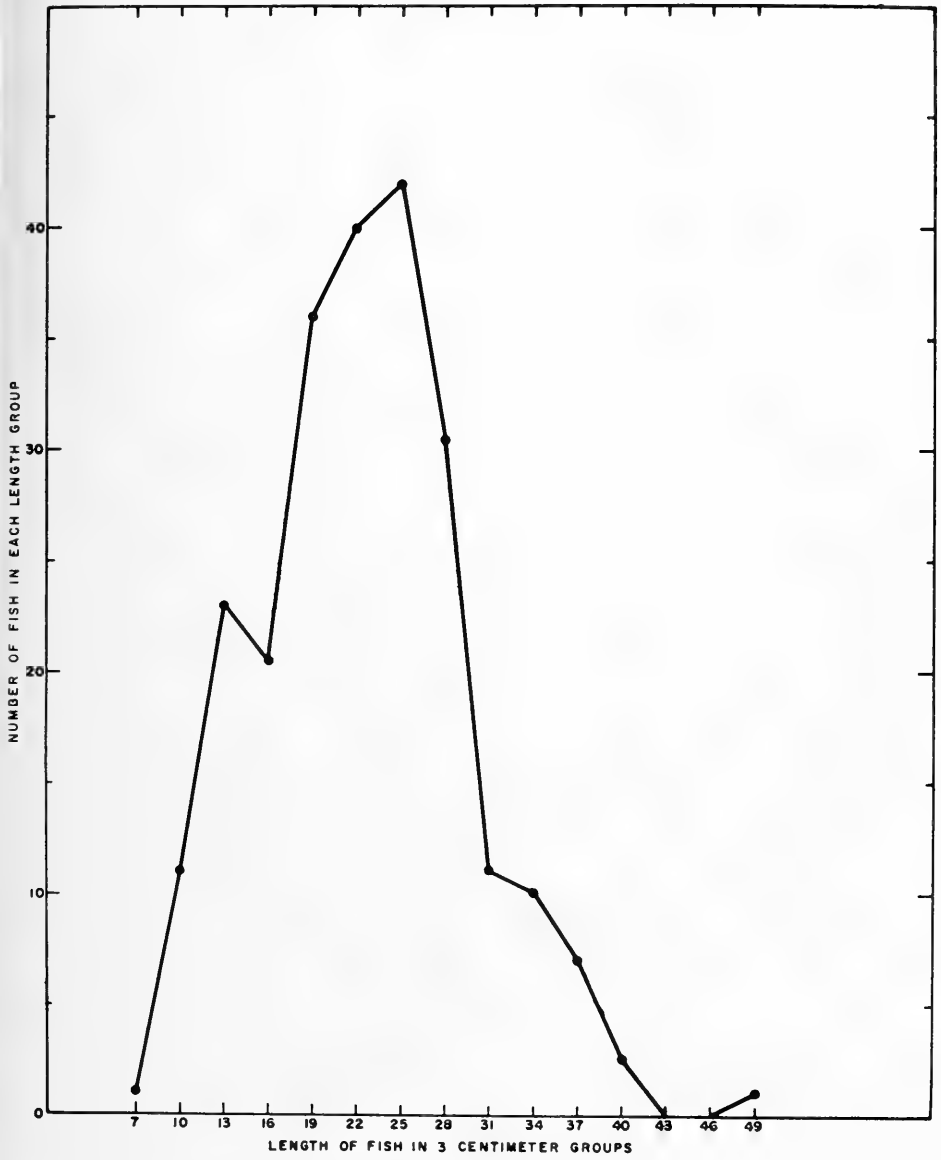

FIGURE 4. Length distribution of landlocked Atlantic salmon in the Terra Nova River system, summer, 1952.

where Y = length, X = age, a = slope, and b = y intercept. The values of a and b have been calculated at 4.5 and 2.4 respectively; thus the equation

$$Y = 4.5X + 2.4$$

fits the observed data.

TABLE 3. — Age-length relationship of young salmon in the upper (S. W. Gander River) Gander River. May-August, 1951. Figures in parentheses indicate the number of fish in each age-class. (Andrews, 1965).

Age in years completed	Actual length	Calculated length ($Y = aX + b$. see text)
1+	7.1(15)	7.1
2+	9.8(91)	9.2
3+	11.3(54)	11.3
4+	13.5(3)	13.4
5+	21.9(2)	15.5
6+	21.0(3)	17.6
7+	33.4(1)	19.3

For comparison age-length data (Table 3) for parr and post-smolts of sea-running Atlantic salmon from the upper Gander River (South West Gander River) have been included in Figure 6. This data also shows a straight line relationship where the equation

$$Y = 2.1X + 5.0$$

fits the observed data. The slopes of the lines indicate a faster rate of growth for landlocked salmon in the Terra Nova River as compared with parr of sea-running Atlantic salmon from the nearby Gander River. Thus age 2+ sea-running salmon in the upper Gander River average 9.2 cm. and landlocked salmon in the Terra Nova River average 11.4 cm.; at 3+ years Gander River salmon average 11.5 cm. whereas landlocked salmon in the Terra Nova River average 15.9 cm. The difference continues to increase with increasing age; thus 6+ year-old salmon in the upper Gander average 17.6 cm. as compared with 29.4 cm. for landlocked salmon in the Terra Nova River. The difference is small at the end of 1+ years but the regression of the lines (Figure 6) indicates that the fry of landlocked salmon are smaller than the fry of sea-running Atlantic salmon, the y intercept of the former being 2.4 cm. and for the latter 5.0 cm.

DISCUSSION

Many of the inland ponds, lakes, rivers, and streams of Newfoundland support well established populations of landlocked salmon and the Terra Nova River system, including its several associated ponds and lakes is no exception. The species is an excellent game fish although it does not reach the size commonly attained by adult Atlantic salmon which migrate upstream from the sea. Maximum length in the Terra Nova River system ranges from 30 to 45 cm. and the maximum weights between 2 and 3 pounds. Scott and Crossman (1964) report that "Generally speaking, the larger waters seem to carry the

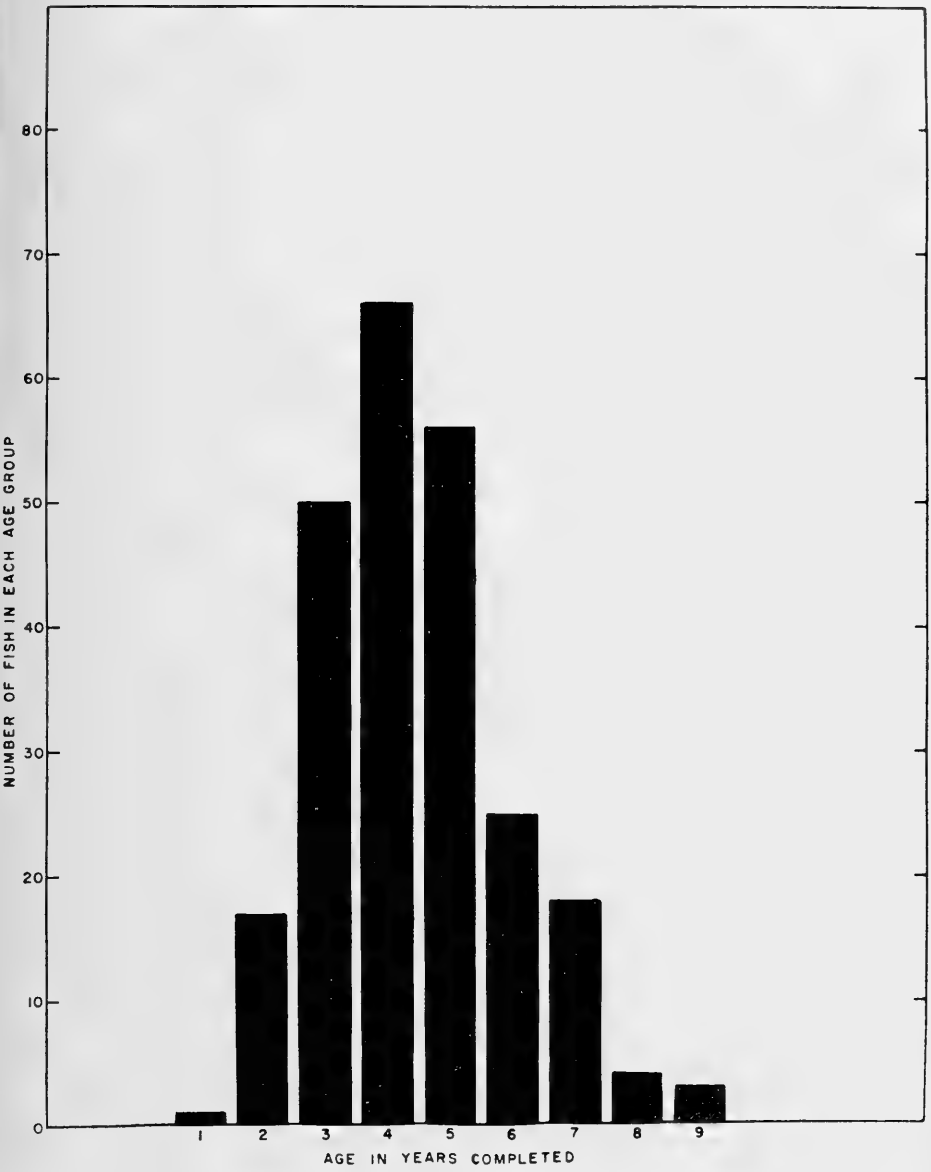

FIGURE 5. Age composition of landlocked Atlantic salmon in the Terra Nova River system, summer, 1952.

larger ouananiche." They also report (1964) ouananiche of 7.0 and 8.5 pounds weight from Kaegudeck Lake, Bay du Nord River, and Red Indian Lake, Exploits River, respectively.

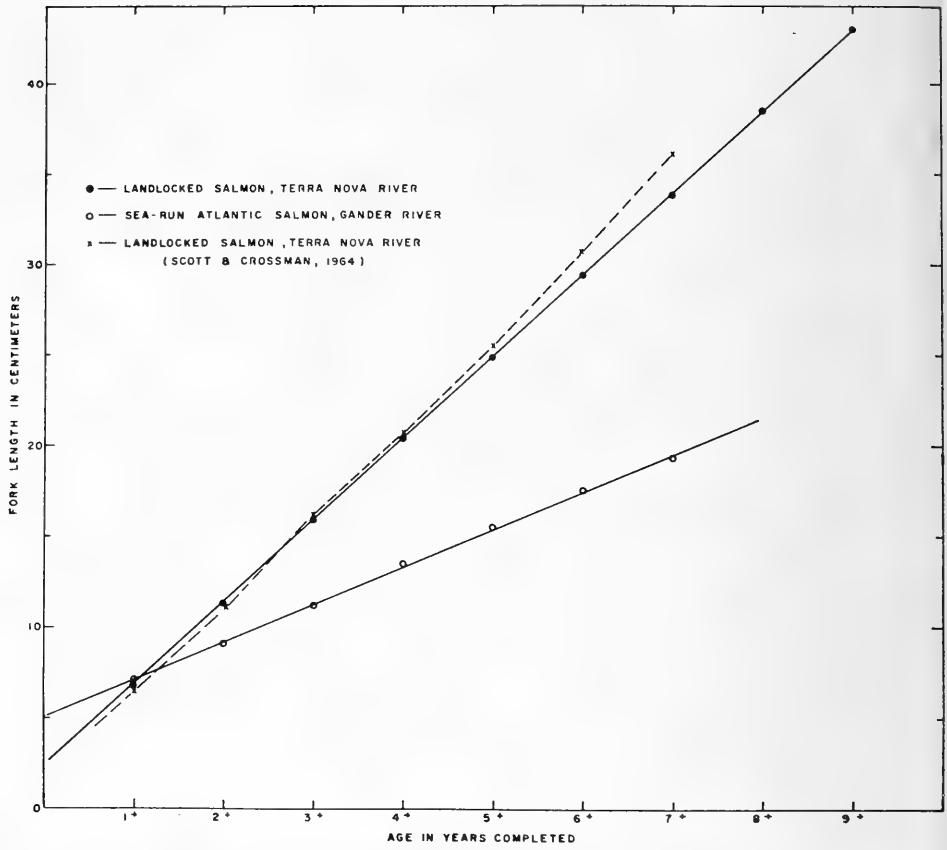

FIGURE 6. Mean length in centimeters of different age-groups; landlocked Atlantic salmon in the Terra Nova River system, summer, 1952.

TABLE 4. — Age-length relationship of 41 landlocked salmon from Terra Nova River system. (Scott and Crossman, 1964, p. 43).

Age	Mean fork length (mm.)	Mean back calculated F.L. from scales (mm.)
1	123	66.5
2	153	112.5
3	208	161.5
4	235	203.8
5	290	255.8
6	319	307.8
7	374	361.2
8	464	418.0

Scott and Crossman (1964) collected 41 landlocked salmon from the Terra Nova River in 1960. Data from this collection are shown in Table 4 and plotted in Figure 6 for comparison with the 1952 data of this paper. Their back calculations from scales for age-length relationships are remarkably similar to our calculated age-length relationships based on the equation

$$Y = 4.5X + 2.4$$

Their direct measurements show a higher rate of growth for each year class. This, they report "may be due to the small sample size. It may also be due to the fact that only the bigger members of the younger age groups were taken in the mesh sizes used."

To conclude, it may be said that the landlocked salmon population of Newfoundland inland waters represent an angling resource which has been little utilized in the past. Its rate of growth in the Terra Nova River system, at least, where "pan sized" fish of 20 cm. (8 inches) or more is reached in from 3 to 4 years indicates that greater utilization, from a biological point of view, may be warranted.

ACKNOWLEDGEMENT

The author wishes to thank Mr. Allenby Pinhorn, Fisheries Research Board of Canada, St. John's, for critically reading the manuscript.

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Received for publication 20 December 1965

REVIEWS

The Mammals of Alberta
By Dewey Soper. Hamley Press Ltd., Edmonton, Alberta, Canada, 1964, 402 pp., 67 coloured pl., 41 figures, maps. $5.00.

Alberta is only the second province with a full book-length treatment of its mammalian fauna and therefore must be considered a leader in this field among the Canadian provinces. It is also fortunate in having the well-known Canadian naturalist Dewey Soper undertake this project. Mr. Soper has been studying the distribution of Alberta mammals for many years.

The author commences with good introductory chapters on the history and environment of Alberta, faunal zones (after Merriam), changes in the mammal fauna, population cycles, fragments of life history, economic values, and zoogeography. Then follow individual accounts of the 153 species and subspecies found in the Province under the headings of vernacular and scientific names, description, size, distribution, habitat, and remarks including life history and unusual records. There are distribution maps and many sketches of heads, skulls and appendages from the author's talented pen. The taxonomic treatment follows that of Miller and Kellogg (1955 U.S. National Museum Bulletin 205) in general, but Soper follows some more recent monographic treatments such as those of Findley (1955) for *Sorex vagrans*, Peterson (1952) for *Alces alces* and Rausch (1953) for *Ursus arctos*. He follows Anderson (1946 National Museum of Canada Bulletin 102) for vernacular names and includes some personal choices.

The application of vernacular names for subspecies has gone out of style recently. The professional taxonomist has no use for them as he has the scientific trinomials, while the many modifying adjectives only serve to confuse the layman. Unfortunately, this book has many examples of the pitfalls caused by the use of vernacular names for subspecies. The full treatment of each subspecies has necessitated the repetition of much life history data under each form and resulted in such statements as "the general biology and behaviour of this subspecies (dusky porcupine) appears to be virtually the same as that of the Alaskan porcupine" (page 253). It introduces pitfalls such as the legend under plate 37 listing the common name "yellow-haired porcupine" — a name not used in the text for any of the three subspecies of porcupine fully described.

Unfortunately most of the distribution maps have been so reduced that the legends are illegible. Fortunately the distribution maps for the big game species, prepared by R. Webb in 1959, are full page size and clear.

It is regrettable that there was such a delay in publishing this book. The author on page 102, writes of the present time as being 1961, and although 1964 is printed on the title page, the book was distributed in 1965. There is only one 1960 paper cited in the text and most papers referred to are prior to 1959. Had the author been able to revise the text recently I expect he would have followed more recent taxonomic treatments. The caribou is a good case in point. Soper follows Anderson's (1946) names and states first that the mountain caribou (*R. fortidans*) is closely related to the barren-ground caribou (*R. arcticus*), but on the next page he states that in many ways it is similar to the woodland caribou (*R. caribou*). Hall and Kelson listed North American caribou as subspecies of the Eurasian reindeer as early as 1959, and this has been widely accepted for several years.

The text is remarkably free of typographical errors. The most obvious is the

repetition of the line containing the beaver's name on page 179.

In spite of the above taxonomic shortcomings, the book is rich in the author's personal animal lore gained over a lifetime of close study of mammals. Few other authors could write such a book and borrow so little from other authors.

A. W. F. BANFIELD

National Museum of Canada,
Ottawa, Ontario.

A New Dictionary of Birds

Edited by A. LANDSBOROUGH THOMSON. McGraw-Hill Book Company, London and New York. 1964. 928 pp., 16 color plates, 32 pp. of photographs, 300 plus line drawings. ($17.50).

As the title implies, this is an extremely comprehensive reference work on birds and their many aspects. It appears to be a worthy successor to Alfred Newton's great classic *A Dictionary of Birds* which, since 1896, has had a long and honorable record. Although similar in plan to Newton, with subject material arranged alphabetically, it is a completely new and different book containing a vast wealth of up-to-date information. It is intended for the ornithologist who requires specific information outside his own particular experience; for biologists needing facts concerning the specialized field of birds; and for the general reader who is looking for particular or general ornithological information.

General information relating to birds as a class is abundantly represented throughout on just about any subject such as classification, structure, evolution, adaptations, behavior, life histories. Even subjects like birds in folk-lore, superstition, literature, and the arts are fully dealt with. Treatment of the various kinds of birds is usually found under the appropriate families and is usually extremely well done (bird names are listed individually to place them for the non-ornithologist in their respective families). Information extends also to other branches of science that affect bird life such as, for example, vegetation, climate, statistical methods, and very many biological terms.

The extremely wide subject coverage is made possible by bringing together special contributions from over 200 ornithologists and other specialists, artists, and photographers in 27 countries of the world. It is profusely, often beautifully, illustrated by 16 color plates, many outstanding photographs, and numerous text figures.

This vast assemblage of information is of very high quality but it is doubtless inevitable that a few errors should creep in. The captions for all three Rock Ptarmigan plumages shown are scrambled (p. 129). The flat assertion is made (p. 400) that the Ruffed Grouse "booms" by striking its wings against its breast and that both sexes "boom"!!

The definition of 'juvenal' completely misses the definite and highly efficient distinction between it and 'juvenile' in North American usage.

The color plates are mostly well done. However Plate 18 is somewhat less impressive than the others. The Gray Jay is shown with a conspicuous white eyering and a too-pale iris that gives it an unnatural stare. Although it is realized that the iris in the Mew Gull is individually variable in color, a bright yellow iris in (presumably) first-year birds is not the usual color in this reviewer's experience at least.

No ornithologist, professional or amateur, can fail to be impressed by the great wealth of up-to-date authoritative information brought together in this handsome volume and no ornithologist should be without it. The British Ornithologists' Union and the editor are to be congratulated on the production of this book which surely is destined to be a classic.

W. EARL GODFREY

National Museum of Canada
Ottawa, Ontario

Principles of Paleontology.
Agnatha, Fishes
Edited by D. V. OBRUCHEV. Published by "Nauka", Moscow, 522 pages, illustrated. 4 rubles 50 copecks (in Russian).

Ichthyologists have been fortunate in having publications which surveyed knowledge on fish fossils. These include Zittel's (1898) *Handbuch der Paläeontologie*, Woodward's (1898-1901) four volume *Catalogue of fossil fishes in the British Museum*, Woodward's revision of Zittel (1932, in English), Grasse's (ed., 1958) three fish volumes of *Traité de Zoologie*, and Piveteau's (ed., 1964—) three fish volumes of *Traité de Paleontologie* now being issued. Romer's (1933 and later editions) *Vertebrate Paleontology* summarily deals with fish. The book reviewed here is a fine addition to these studies of palaeoichthyology.

The study of fossil fishes in North America and particularly Canada has not received the attention it deserves. This is not from the lack of suitable deposits in Canada. All of the major studies above are European. The reviewers would like to draw this untramelled Canadian field of study to the attention of young biologists.

The *Principles of Paleontology* comprises a series of volumes being published on different fossil groups. The volume on fishes is finely bound in green cloth. Its binding, paper and illustrations reflect the current rise in quality of Russian publications.

The text is preceded by a table of contents, a stratigraphical table (without geological age) and a short introduction, and ends with an index to taxa. The body of the text is divided into chapters, each of which covers a class or subclass, is individually authored and is followed by its own bibliography and set of plates. Each chapter is well-salted with text-figures. Descriptions and geological spans are given for each fossil taxon down to the genus; taxa not represented by fossils are omitted. The author and date is cited for most families and genera.

The classes dealt with are Diplorhina, Monorhina, Acanthodei, Chondrichthyes and Osteichthyes, while a last chapter includes as *incertae sedis* the Order Conodonti. Under the major taxa are included sections on history, morphology, systematics, ecology, and geological and biological significance.

The classification is generally conservative. Fewer classes are recognized than in the somewhat split classification of Berg's (1940) *Classification of fishes both recent and fossil*. Separate classes for hagfishes, lampreys, and ratfishes, for example, are dropped. Surprisingly the taxonomic endings of the American, Stenzel are adopted, whereas most North Americans currently follow the Russian ichthyologist Berg! The union of the crossopterygians and lungfishes in a subclass Sarcopterygii does not seem well advised; their nasal passages have been shown to be ontogenetically dissimilar.

The coverage of Osteichthyes seems reasonably complete, although *Mallotus* and *Artediellus* known from Pleistocene fossils and the Ramphosoidei are omitted. Unfortunately Patterson's (1964) study on Mesozoic acanthopterygians was published too late for inclusion. Although some publications up to 1963 are included, Parsch's (1962) study on fossil fish of Alberta, and Uyeno and Miller's (1963) important survey of late Cenozoic freshwater fish records from North America have been omitted.

Compilation is of course necessary to produce a work of this sort. But there are new data and new figures. New taxa include — in the Heterostraci: Olbiaspidida (Order) and Olbiaspididae (p. 78); in the Monorhina: Tannuaspididae (p. 98); in the Placodermi: Radotinidae (p. 132); Groenlandaspidae (p. 143); Euleptaspidae (p. 144); Hussakofiidae (p. 148); Erromenosteidae (p. 150); in the Acanthodii: Polyacrodontidae (p. 212); in the Chondrichthyes: Pseudodontichthyidae (p. 255). The lack of new phylogenetic dendrograms is disappointing.

The chapter on conodonts uses a classification with families, though most students of conodonts today — at least in the west — no longer retain this category for what are recognised as "form genera", not true genera. It is interesting to recall that though conodonts were discovered first in 1859 in the Leningrad area, they have since been almost totally ignored by Russian workers. The present chapter leans heavily upon recent German and American work.

This volume will be of considerable value in the study and identification of fossils because of its descriptions and many figures and its literature summaries at the end of each chapter.

D. E. McALLISTER
D. L. DINELEY

National Museum of Canada, Ottawa, and
University of Ottawa, Ottawa, Ontario.

Tuktu: A Question of Survival

By FRASER SYMINGTON. Canadian Wildlife Service, Department of Northern Affairs and National Resources, Queen's Printer, Ottawa, 1965. 92 pp. 19 plates and 1 fold-out map. $2.00.

This is a popular treatment of the "caribou problem" which faces federal and provincial game authorities who are charged with managing this important northern renewable natural resource. Mr. Symington has done a very capable job of translating the many official reports of field biologists into a more digestible language for the layman, without losing any of the feeling of the rawness of the land and the urgency of the situation.

The booklet opens with a pictorial essay on the barren-ground caribou and then is introduced by the Honourable Arthur Laing, Minister of Northern Affairs and National Resources. The author treats the problem in a series of chapters on the land, the caribou and the people and concludes by presenting a caribou management program with an outline of basic principles. This booklet should perform the important task of bringing the public up to date on the barren-ground caribou situation in northern Canada.

A. W. F. BANFIELD

National Museum of Canada,
Ottawa, Ontario.

Fishes of the Sea of Japan and neighbouring parts of the Okhotsk and Yellow Seas.

By G. U. LINDBERG and M. I. LEGEZA. Published by "Nauka", Moscow and Leningrad, Part I, 1959, 207 pages, 108 figures; Part II, 1965, 389 pages, 324 figures (In Russian).

The isolation of the Sea of Japan by sills, its geological history and its mixed arctic, temperate and tropical faunal elements make it especially interesting to the ichthyologist. The fish fauna of the Sea of Japan has not been recently surveyed as a whole. Matsubara (1955) in *Fish morphology and hierarchy* surveyed the Japanese portion of the Sea of Japan and Chung (ed., 1961) in *The fauna of Korea, fishes*, the Korean portion. The former does not contain synonymies and descriptions and the latter does not give synonymies. Lindberg and Legeza's study give both of these plus keys, distribution and a figure for each species. Part I includes from the lampreys to the ratfishes, Part II from the sturgeons to the threadfins, and presumably a later part(s) will cover the remainder of the fishes. This study will be valuable to those interested in the fish fauna of the Japan Sea and to those interested in the amphi-pacific members of the Canadian Pacific fish fauna. It is hoped that the last part will contain a zoogeographical discussion of the area.

D. E. McALLISTER

National Museum of Canada
Ottawa, Ontario.

NOTES

Some Unusual Bird Records from the Peace River District

Glaucous-winged Gull, *Larus glaucescens*. Mr. Gavin Craig of Wembley, Alberta, has kindly allowed me to examine some specimens in his collection of mounted birds. Among them are two sub-adult gulls of this species. One of these is in second-year plumage. It was found shot at Bear Lake about 25 kilometers northwest of Grande Prairie in mid-September 1958. The other is about a year older and is coming into adult plumage. It was taken at the same place on 11 August 1959. Mr. Craig says (correspondence), "It was very thin and seemed sick", and also, "During the fall of 1959 there were 10 or 12 second year gulls of this kind in the Bear Lake area". Neither specimen was sexed.

These specimens constitute earlier records of the Glaucous-winged Gull in Alberta than that previously reported by Merilees (1961, Canadian Field-Naturalist 75:170). It appears that Glaucous-winged Gulls, especially those in their second year, may be of fairly regular occurrence in the Peace River District and that they occasionally wander farther east.

Greater Scaup, *Aythya marila*.

On 9 October 1961, a Greater Scaup was shot by Mr. Frank Smith at Lake Saskatoon north of Wembley, Alberta. The specimen was mounted in flying position and placed in the collection of Gavin Craig. Although not sexed it appears to be a female. Several Lesser Scaups were shot from flocks on this occasion but this bird was alone. Mr. Craig says that in the flesh this one was noticeably larger. The extension of white onto the primaries, the size and shape of the beak and of the "nail", make identification certain. Two Greater Scaups taken in northeastern Alberta on 13 May 1920, are the only other authenticated records of this species in the province.

Western Kingbird, *Tyrannus verticalis*.

On 31 May 1965, Mr. Craig saw a Western Kingbird around his home at Wembley. It stayed for some time allowing a close approach and positive identification.

Barn Swallow, *Hirundo rustica*.

The barn swallow was unknown as a breeding bird in the Peace River District in 1958 according to Salt and Wilk (*The Birds of Alberta*, Department of Economic Affairs, Government of Alberta). In June, 1964, A. J. Erskine saw Barn Swallows in the Lesser Slave Lake area at Desmarais, Grouard, and Joussard, and found a nest with young at Red Earth on 9 July. On 31 May 1965, Barn Swallows were nesting in a porch at Gavin Craig's home at Wembley. Mr. Craig says he has seen the species before and believes they nest "here and there in the Peace River Area". A similar westward extension of breeding range of this species has been noted in the Rocky Mountains area of Alberta. Barn Swallows now nest on buildings at Johnson's Canyon, about 30 kilometers west of Banff, and at Lake Louise.

Varied Thrush, *Ixoreus naevius*.

On 21 June 1965, John Hubbard, a zoology student at the University of Michigan, collected two Varied Thrushes about 55 kilometers south-southwest of Grande Prairie. The skeletons have been placed in the collection of the University of Michigan. Both specimens were females with brood patches and post-ovulatory ovaries. Both were carrying food. There seems no doubt that they were breeding birds. These specimens extend the known breeding range of the Varied Thrush in Alberta northward into a region which is some 75 kilometers away from the mountain habitat usually occupied by this species in the province.

BLACK-THROATED GREEN WARBLER
Dendroica virens.

Mr. Hubbard found this species not uncommon in suitable habitat south of Grande Prairie. Of greater significance, however, is the fact that he heard several singing males in the Chetwynd-Moberly Lake area of British Columbia some 100 kilometers west of the Alberta border. He collected a male near Chetwynd on 25 June 1965. This specimen is in the collection of the University of Michigan. Munro and Cowan (1947, *A Review of the Bird Fauna of British Columbia*, B.C. Provincial Museum) give no records of the species for the province. This specimen, therefore, represents the first authenticated record of the Black-throated Green Warbler in British Columbia.

W. RAY SALT

Department of Anatomy
University of Alberta
Edmonton, Alberta
8 July 1965

An Unexplained Mass Mortality of Turtles

LINDSAY's presentation of an unexplained case of ophidian mortality (1966 Canadian Field-Naturalist 80 (1): 59) has prompted this note on an observed mass mortality in a population of turtles. Although these data were not followed up with tests to determine the cause of death, they may serve to emphasize that catastrophies do happen in reptilian populations and perhaps will alert some future observer to thoroughly investigate a similar discovery.

On the afternoon of May 15, 1954 I visited a large shallow pond about one mile south of Stittsville, Carleton County, Ontario and found numbers of dead, bloated turtles floating in the water near shore. Examined at that time were Blanding's Turtle, *Emydoidea blandingi*, a large male and a small female, and Midland Painted Turtle, *Chrysemys picta marginata*, one large female and four medium sized males. The afternoon of May 19 the pond was revisited and a count of all dead turtles was taken. One six-inch female *E. blandingi* and forty-seven *C. p. marginata* were examined. The carapace length of the latter, to the nearest half inch are tabulated below by sex.

Carapace:	3	3.5	4	4.5	5	5.5	6	6.5	7	Total
Females	7	0	2	1	5	1	9	3	1	29
Males	0	0	2	0	8	3	5	0	0	18

The *Chrysemys* exhibited relatively little morphological variation and all had a dark mid-plastral figure though on four (three females and one male, all six-inch specimens) this marking was faint. All had a narrow red line down the middle of the carapace and other characteristics were typical of *marginata*. On May 20 the pond was again examined and four additional *Chrysemys*, overlooked previously, were found, three females and one male, all six inches in shell length. This brought the total to 59 turtles; 56 *Chrysemys* (33 females, 23 males) and 3 *Emydoidea* (2 females, 1 male). No live turtles were observed on any visit, though the weather was sunny and mild on each occasion.

There were no external clues on any of the turtles to indicate how they might have died. Unfortunately, at that time I was ignorant of the services available from the Animal Diseases Research Institute, Canada Department of Agriculture, and made no effort to save any of these bloated specimens.

The pond, though devoid of reptilian life, contained active amphibians. *Pseudacris t. triseriata* (May 15, 19, 20), *Rana clamitans* (May 15, 20) and *Hyla versicolor* (May 15) were heard calling on the dates given. *Rana pipiens* were seen May 19 and 20, with about a dozen in evidence on the first date. No dead amphibians were noted at any time.

It is relatively unusual to see dead reptiles or amphibians in the field, other than road kills, and at present there is no satisfactory explanation for the observations reported here.

J. SHERMAN BLEAKNEY

Biology Department
Acadia University
Wolfville, Nova Scotia
8 April 1965

New Nesting Records and Clarification of Breeding Status Of Some Birds in the Perry River Area, Northwest Territories

THE PURPOSE of this paper is to report new nesting records for the Perry River area, N.W.T., and to clarify the breeding status of some species in that area for which previous information is inconclusive. Observations were made in the Perry River region from July 8 to August 12, 1965, while the writer was assisting J. P. Ryder in Canadian Wildlife Service studies of Ross's geese (*Anser rossii*).

The first annotated list of birds of the Perry River area was presented by Gavin (1947). That work was supplemented by a detailed ornithological survey by Hanson, Queneau, and Scott in 1949 (Hanson, *et al*, 1956). Aleksiuk (1964) recorded one addition and changes in the status of some species. Observations on the avifauna of areas to the east and west of Perry River were reported by Fraser (1957). Observations for Adelaide Peninsula were reported by Macpherson and Manning (1959), and for Bathurst Inlet by McEwen (1957).

Squatarola squatarola. BLACK-BELLIED PLOVER

Gavin reported that the Black-bellied Plover was a "fairly common summer visitor", but did not give information on breeding status. Hanson, *et al*, and Aleksiuk reported it to be only a migrant at Perry River. Macpherson and Manning stated that the Black-bellied Plover was the commonest plover on the Adelaide Peninsula, some 100 miles east of Perry River, although no nests were found.

On July 9, 1965, a nest containing four eggs was found on a low-lying Precambrian outcropping near the mouth of the Perry River. The eggs pipped on July 25 and hatched by July 27. One egg failed to hatch.

Erolia bairdii. BAIRD'S SANDPIPER

Baird's Sandpiper, not recorded by Gavin, was reported by Aleksiuk to occur probably only as a migrant. Hanson, *et al*, believed that it possibly bred in the area.

Observations in 1965 confirm the latter generalization. On July 21 a nest containing four pipped eggs was found on a rocky hillside on Perry Island. Hatching was completed by July 22. Another pair was observed feigning injury on Perry Island on July 22, but no nest or young were located. A third pair also feigning injury was observed on July 24 near the mouth of the Perry River but no nest or young were found.

Erolia alpina. DUNLIN

This species was not recorded by Gavin or Aleksiuk, and Fraser did not record it in the central Canadian Arctic. Hanson, *et al*, observed only three individuals and presumed that the species did not breed at Perry River. Macpherson and Manning state that it "is a rare migrant on the east side of Sherman Basin but perhaps breeds on the east coast and in other parts of the Adelaide Peninsula." On July 17 a pair of adults with a brood of four newly hatched young were found on the tundra 15 miles inland near the Perry River.

Lobipes lobatus. NORTHERN PHALAROPE

The Northern Phalarope was found to be uncommon by Hanson, *et al*, and Aleksiuk. Gavin earlier reported that it is "as abundant as the Red Phalarope (*Phalaropus fulicarius*) and nests in similar situations." My observations in 1965 showed it to be more common, or at least more conspicuous, than the Red Phalarope. On July 14 a nest containing four eggs was found in moist grass near a small tundra pond four miles inland. On July 31 one adult and three young were seen feeding on an island in the Perry River.

Anthus spinoletta. WATER PIPIT

Only Hanson, *et al*, recorded this species at Perry River. His party observed adults feeding full-grown young on July 27, 1949.

The Water Pipit was common in 1965, being found on nearly every high Precambrian outcropping, both on coastal islands and inland. A nest containing four newly-hatched young and one egg was found on the summit of an outcropping on Winter Island on July 14. Three pairs were observed feeding full-grown young on Perry Island on July 21. A second nest containing three young was found near the mouth of the Perry River on July 24. A brood of four was observed the same day in proximity to the second nest mentioned above.

Plectrophenax nivalis. SNOW BUNTING

Gavin reported the Snow Bunting to be a very abundant nester on coastal islands and in the interior. Aleksiuk and Hanson, *et al*, found it to be only a common migrant and a scarce summer resident. McEwen found this species to be an uncommon breeder at Bathurst Inlet about 100 miles west of the Perry River. My observations in 1965 are in accordance with those of Gavin, for this species is a common summer resident and breeding bird, especially along the coast and on the coastal islands. A nest containing four young and one egg was found on July 14 near our base camp at the mouth of the Perry River. On July 16 the nest contained five young. During the last two weeks of July several young were observed. Some were able to fly only short distances while others were capable of sustained flight.

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SPENCER G. SEALY

Department of Zoology
University of British Columbia
Vancouver 8, British Columbia
28 September 1965

The First Breeding Record of Brandt's Cormorant in Canada

THE RANGE of the Brandt's Cormorant, (*Phalacrocorax penicillatus*) extends from southeastern Alaska to Baja California (Bent, 1922). In British Columbia it is a common fall and winter visitor to southern parts of the Strait of Georgia and to the waters near Victoria, and is present in large numbers in summer on the west coast of Vancouver Island (Munro and Cowan 1947). Although this cormorant is known to breed on the coast of the State of Washington and southern Puget Sound region at Lopez and Matia Islands (Drent and Guiguet, 1961), the only suggestion of nesting in British Columbia is based on the presence of adult birds on Solander Island in summer (Munro and Cowan 1947).

In the summer of 1964, R. Y. Edwards, B.C. Department of Recreation and Conservation, and one of the authors (D.S.) noticed many cormorants on and around Sea-lion Rocks, five barren islets in Wickaninnish Bay (49°03′ N. latitude, 125°43′ W. longitude) 0.5 to 0.8 miles from shore and lying just south of Green Point. The cormorants were concentrat-

ed on the largest island which is about 180 yards by 60 yards in area and rises about 20 feet above maximum high tide level. Study with a 15X telescope showed that the cormorants were Brandt's Cormorants and the fact that individual birds were seen carrying seaweeds to the rocks suggested the possibility of nesting.

On July 26, 1965, Mr. T. A. White, crab fisherman from Tofino, put us ashore on the large island. On top of the jagged, but nearly level, lee side of the island about 15 feet above maximum high tide level we found a breeding colony of Brandt's Cormorants. The colony consisted of 110 nests in three groups forming a rough triangle. Group 1 was about 35 feet from group 2 and a hundred feet from group 3, while group 2 was fifty feet from group 3. Nests were low bowls three to four feet apart. They were constructed mainly of dry false eelgrass, (*Phyllospadix torreyi* Wats.), as well as some marine algae and a few feathers. Eggs and young varied from two to four in each nest. The largest group of nests had fewer and smaller young than the other two groups. The ratio of young to eggs and the size of these young in group 2 seemed to suggest that this was the most desirable site. Group 1, however, had more nests. Possibly this site, although not as good as the other two, had a greater area suitable for nest building. All nests were built at the edge of cliffs where cormorants could easily escape by "falling off".

	Nests	Eggs	Young
Group 1	58	132	14
Group 2	29	21	66
Group 3	23	21	41
Total	110	174	121

Breeding adults were remarkably easy to approach. Most, particularly those with young, remained on their nests until we were within 20 to 25 feet. At this distance the buffy band across the throat and blue gular pouch were plainly visible. Good colour slides were obtained. Adults returned to their nests very soon after we moved away from the nests.

The only other breeding bird species encountered was the Glaucous-winged Gull. Downy young were abundant. Other birds observed on the islet were Black Oystercatchers, one Pelagic Cormorant, Surfbirds, Ruddy Turnstones, Black Turnstones, Wandering Tattlers, one Dowitcher, and California Gulls.

The size of the cormorant colony may be restricted by other animals. It seems possible that competition for nesting sites exists between cormorants and gulls (an estimated 1,000), and large numbers of roosting non-breeding cormorants may compete for space with breeding birds. The rocks are used also by northern sealions, *Eumetopia jubata*. More than fifty were present during our visit; two hundred were counted there in 1964. It is possible that these ponderous animals help to restrict the space available for cormorant nests.

This colony of Brandt's Cormorants in Wickaninnish Bay, Vancouver Island, is the first to be discovered in Canadian waters, but other colonies may be found when this coast becomes better known ornithologically.

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DAVID STIRLING
FRANK BUFFAM

Parks Branch
Department of Recreation and Conservation
Victoria, B.C.
15 October 1965

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Articles

Reviews

Notes

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BOTANICAL INVESTIGATIONS IN NORTHEASTERN SASKATCHEWAN: THE SUBARCTIC PATTERSON-HASBALA LAKES REGION

George W. Argus
W. P. Fraser Herbarium, University of Saskatchewan, Saskatoon

Introduction

Most vegetation maps of Canada depict a triangle in northeastern Saskatchewan within the subarctic. Rowe (1959) includes this region in his Northwestern Transition Section in which "coniferous forest passes northward into a zone of subarctic woodland"; Porsild (1958) includes it in the subarctic forest-tundra transition; and it is contiguous with Ritchie's (1962) "open spruce forest with lichen scrub" of Manitoba.

If this region does lie within the subarctic, botanical investigation should reveal (1) some low arctic species unknown in Saskatchewan (2) tundra vegetation, at least in exposed habitats and (3) the northern edge of the range of some boreal taxa. The study was designed to examine these possibilities and to add to the data concerning the taxonomy and distribution of taxa in the flora of northern Saskatchewan.

The locality selected for study was the Patterson-Hasbala Lakes region (Figure 1) which lies well within the supposed subarctic triangle in northeastern Saskatchewan. As the interests of the field party included ornithology as well as botany an extensive survey method, covering as much area as possible, was used. Although this method minimized the opportunity for intensive study, it led to the chance discovery of tundra habitats and unusual plant distributions which might otherwise have been missed. In 1962 and 1963 a total of 29 days were spent in the field; 7 days at "Quillwort" Lake (2.4 km south of Hasbala Lake), 11 days at Hasbala Lake, 10 days at Patterson Lake and 1 day at Warren Lake (Lat. 59°45′ N., Long. 102°42′ W.).

Acknowledgments

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I am indebted to my field companions, Dr. R. Nero and Mr. R. Carson (the latter in 1963 only) for their cooperation and assistance without which this research would not have been possible. I appreciate the efforts of the specialists who examined certain groups of plants: J. Calder, A. Cronquist, H. Crum, W. Dore, M. Hale, F. Hermann, A. E. Porsild, C. Reed, R. Shoenike, J. Thomson, and R. & A. Tryon. I appreciate the critical comments of Mr. M.

Mailing date of this number: 8th December, 1966.

Swan and the editorial advice provided by Mrs. Sandomirsky, Publications Editor, University of Saskatchewan.

PREVIOUS BOTANICAL INVESTIGATIONS

No botanical studies have been conducted in the subarctic triangle of northeastern Saskatchewan but several have been made in the vicinity. The earliest botanical collections in the vicinity of northeastern Saskatchewan were made by J. W. Tyrrell, a member of J. B. Tyrrell's geological expedition in 1893 (J. B. Tyrrell, 1898). During 1893 the expedition passed through Saskatchewan traveling from Lake Athabasca to Black Lake and northward on the Chipman River to Selwyn Lake, about 150 km west of Hasbala Lake. On a second trip in 1894 they passed about 48 km east of Hasbala Lake on the Little Partridge River, Manitoba, enroute to Kasba Lake, N.W.T. Unfortunately, there were no plants collected on the 1894 trip; however, some botanical observations were made. The area south of Kasba Lake was described as "generally low, flat and wooded with small black spruce". Stunted aspen were observed at the foot of a dry esker and *Vaccinium vitis-idaea*, *Empetrum nigrum* and *Arctostaphylos alpina* (as *A. arctica*) were noted to be abundant.

More recent collections have been made in the nearby northern coniferous forest and the arctic tundra. Collections in the northern coniferous forest have been made by Scotter (1961, 1964, 1965 and Thomson & Scotter, 1961), Ritchie (1959) and Baldwin (1953). Scotter's collections from the vicinity of Black Lake, Saskatchewan and Cochrane River, Manitoba (including Kasmere Lake and Fort Hall, about 73 km southeast of Hasbala Lake) were made in connection with his ecological study of the barren-ground caribou range. Ritchie's ecological studies were centered in Manitoba near the confluence of the Big Spruce and Seal Rivers, about 320 km southeast of the area described herein. Baldwin's collections were made over an area ranging from Reindeer Lake northward to Nueltin Lake, Manitoba.

Collections from the southern edge of the arctic tundra northeast of Saskatchewan have been made by several collectors. Harper's collection from a sparsely wooded portion of northwestern Nueltin Lake, N.W.T. were identified and published by A. E. Porsild (1950). Scoggan's collections from Baralzon and Nejanilini Lakes were listed in 1952 and later summarized in his Flora of Manitoba (1957). Larsen (1965) carried out ecological investigations at the north end of Ennadai Lake.

STUDY AREA

In general, the topography of northeastern Saskatchewan is rolling with elevations up to about 1,550 feet. A variable thickness of glacial till, consisting of loosely packed gravels containing many boulders derived from the underlying bedrock, covers most of the region (Taylor, 1963). At about longitude 104°W. we observed a change in the depth of the surficial till deposit. West of this point exposed bedrock was prominent and the till deposit was thin, but, to the east, little bedrock was exposed and such glacial features as eskers, drumlinoid ridges, ribbed moraines and abandoned beach lines were prominent.

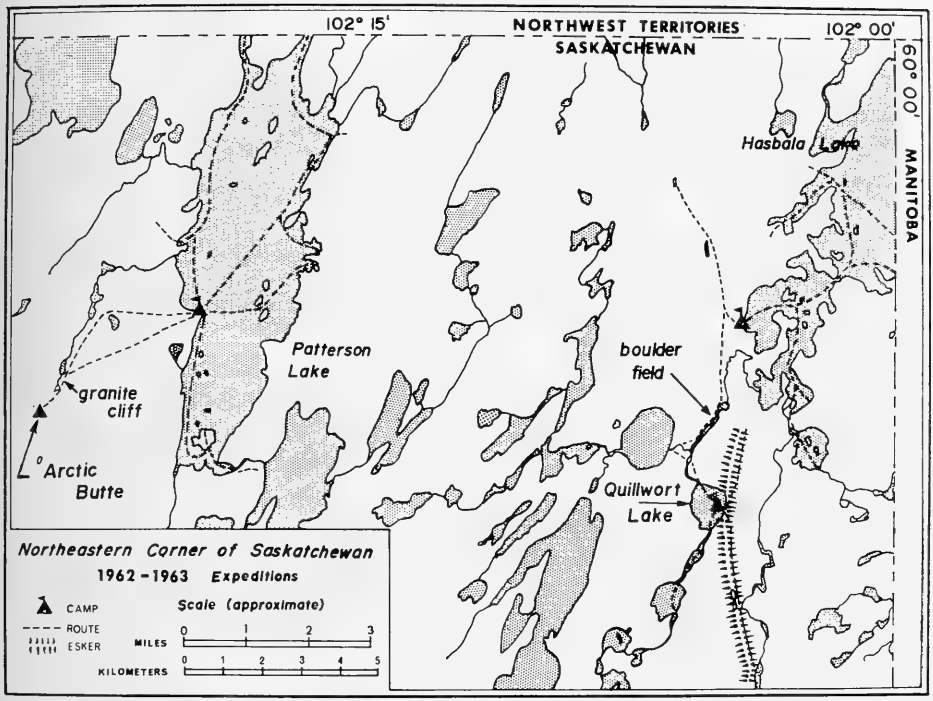

FIGURE 1. The northeastern corner of Saskatchewan.

Sand deposits located south and west of Hasbala Lake are probably attributable to Glacial Lake Kazan, in the southwestern District of Keewatin, which was described by Lee (1959). This Pleistocene Lake was estimated to stand between 1,253 and 1,260 feet above sea level and would have innundated much of the area around Hasbala and Patterson Lakes.

The strata underlying much of the area is granite which is often red in colour (Tremblay, 1959). Red granite cliffs and a hill composed of red granite were observed west of Patterson Lake. In the region around Hasbala Lake, which Tremblay did not visit, we observed metamorphic cliffs composed of gneisses similar to those described by Tremblay as "fine- to medium-grained, granular, massive to foliated, quartz-feldspar-biotite gneiss".

PLANT COMMUNITIES

A brief consideration of the vegetation of northeastern Saskatchewan will permit a better understanding of the habitat notes in the annotated catalogue of plant species. The communities described here were recognizable in the field; however, their limits are arbitrary. Vegetational patterns are often obscured by the complex regeneration of plants after fire and habitat intergradation. Some of the following communities were dominant features in the

landscape; others are noteworthy minor features. The types described in this report are:

Forest Communities
- *Picea mariana* – lichen woods
- *Picea mariana* – feather moss woods
- *Picea mariana* muskegs
- *Pinus banksiana* woods
- *Picea glauca* woods

Lake Margin Communities
- Aquatics
- *Carex* fens
- *Salix* fens
- Rocky lake margins
- Sand beaches

Esker Communities
- Slopes and summits
- Kettles
- Sand blowouts
- Open sandy–gravel surfaces

Cliff Communities
- Granite cliff
- Metamorphic cliff

Tundra Communities
- Moist boulder field
- Dry rock field

Forest Communities

A forest vegetation dominated by *Picea mariana* covers much of northeastern Saskatchewan. *Picea mariana*, somewhat smaller than in forests to the south and west, occupies a variety of habitats from dry esker ridges to wet muskegs and stream margins. Individuals of *Pinus banksiana*, *Betula "papyrifera"*, *Larix laricina*, and, rarely, *Picea glauca* may be associated with *P. mariana*, but pure stands of these associates are uncommon. The following forest types are recognized (1) *Picea mariana* – lichen woods, (2) *Picea mariana* – feather moss woods, (3) *Picea mariana* muskegs and (4) *Pinus banksiana* woods. These four forest types are the predominant, more or less stable, forests observed in the area. Complex mixed forests are common resulting from intergradation of habitats and regeneration after fire which is a major environmental factor in subarctic forests (Scotter, 1965).

PICEA MARIANA–LICHEN WOODS. Dry woods dominated by *Picea mariana*, with a lichen-covered floor, occupied the summits and slopes of eskers, till ridges, old beach ridges, and outcrops covered with a shallow soil. These woods were park-like with widely spaced trees and sparse undergrowth. The ground cover was dominated by *Stereocaulon paschale*, *Cladonia* spp., and *Cetraria nivalis*. Interspersed among these lichens were the mosses *Ptilium*

crista-castrensis and *Hylocomium splendens* and mats of *Empetrum nigrum*, *Vaccinium vitis-idaea* and *Loiseuleria procumbens*. The lycopods *Lycopodium annotinum*, *L. clavatum*, *L. complanatum* and *L. sabinaefolium* var. *sitchensis* were locally abundant. The shrub layer was composed of scattered clumps of *Betula glandulosa*, *Vaccinium myrtilloides*, *V. uliginosum*, *Ledum groenlandicum*, *Salix arbusculoides*, *S. bebbiana*, *S. glauca* and *S. planifolia*. The herb layer was sparse, and mainly consisted of *Calamagrostis canadensis*, *Oryzopsis pungens*, *Comandra livida*, *Epilobium angustifolium* and *Pedicularis labradorica*. *Pinus banksiana*, *Betula "papyrifera"* and *B. fontinalis* occurred as secondary species.

A soil pit dug in a till ridge west of Patterson Lake revealed a shallow organic horizon of 2 cm above 33 cm of sandy-stony parent material which was stained a reddish-brown colour. There was no frost at 35 cm, the depth of the pit.

PICEA MARIANA – FEATHER MOSS WOODS. On the lower slopes of eskers, till ridges, stream margins and other well drained mesic sites there was an increase in the proportion of the forest floor covered by feather mosses, principally *Hylocomium splendens*, *Pleurozium scherberi*, *Ptilium crista-castrensis*, *Ptilidium ciliare* and *Rhacomitrium canescens*. The shrub layer was more dense and lacked the park-like aspect of the *Picea mariana* – lichen woods. Common shrubs here included *Betula glandulosa*, *Alnus crispa* and *Salix bebbiana*. Less common were *Salix planifolia*, *S. arbusculoides*, *Ribes triste* and *Rubus idaeus* var. *strigosus*. The ground cover was usually sparse and included *Lycopodium annotinum*, *L. clavatum*, *Agrostis borealis*, *Calamagrostis canadensis*, *Carex capillaris*, *C. leptalea*, *C. vaginata*, *Smilacina trifolia*, *Stellaria longifolia*, *Mitella nuda*, *Ribes triste*, *Rubus chamaemorus*, *Viola palustris*, *Linnaea borealis* ssp. *americana*, *Erigeron lonchophyllus*, *Petasites frigidus* var. *palmatus*, *Taraxacum certophorum* and scattered patches of the lichen *Parmelia physodes*.

In moister habitats *Sphagnum* increased in importance. In this zone, between the feather moss woods and the muskegs, the forest floor usually consisted of patches of feather mosses, active *Sphagnum fuscum* hummocks, and dead mosses covered with lichens. Soil pits dug into inactive *Sphagnum* hummocks and lichen patches revealed a shallow but variable peat layer 8-36 cm deep and no frost at 40-50 cm, the depth of the pits. An actively growing *Sphagnum* hummock contained frost at 33 cm and no sign of inorganic material.

PICEA MARIANA MUSKEG. In areas of impeded drainage a vegetation dominated by *Picea mariana* and several species of *Sphagnum* occurred. The trees of *Picea mariana* were more closely spaced than in the other forest types and were sometimes accompanied by individuals of *Larix laricina*. The dominant shrubs were *Betula glandulosa*, *Ledum groenlandicum* and *Salix planifolia*. Low shrubs of frequent occurrence were *Rubus chamaemorus*, *Vaccinium vitis-idaea*, *Cornus canadensis*, *Salix myrtillifolia*, *Ribes hudsonianum*, *Kalmia polifolia* and *Chamaedaphne calyculata*. The ground cover

was mainly *Sphagnum fuscum* and other sphagna including *S. warnstorfianum*, *S. lindbergii*, *S. wulfianum*, and, in wet depressions, *S. cuspidatum*. Other mosses which occurred in varying abundance included *Aulacomnium palustre*, *Drepanocladus venicosus*, *Hylocomium splendens*, *Tomentypnum nitens* and *Pleurozium schreberi*. Herbs which occurred scattered in the mosses were *Equisetum sylvaticum*, *Carex capillaris*, *C. magellanica*, *Scirpus caespitosus*, *Smilacina trifolia*, *Parnassia multiseta*, *Rubus acaulis*, *Pedicularis labradorica*, *Petasites frigidus* var. *palmatus*, *Erigeron lonchophyllus* and *Senecio pauperculus*.

Bare silt frost boils were sometimes observed in intermittent drainage channels between *Sphagnum* hummocks. These frost boils contained a unique assemblage of arctic and subarctic species including *Juncus triglumis* ssp. *albescens*, *J. castaneus* and *Carex bicolor*. Here also were *Tofieldia pusilla*, *Potentilla fruticosa* and *Senecio pauperculus*.

Two general types of treeless vegetation were located in poorly drained pockets within the *Picea mariana* muskegs. Both types had a peaty substrate and graded into *Picea mariana* muskeg. The first was the SPHAGNUM BOG which was characterized by the dominance of *Sphagnum fuscum* and other sphagna including *S. recurvum*. Bogs of this type were observed at the margin of a lake south of Hasbala Lake and west of Patterson Lake. Characteristic species included *Carex limosa*, *Salix pedicellaris*, *Eriophorum chamissonis*, *Drosera anglica*, *Chamaedaphne calyculata*, *Utricularia intermedia* and the mosses *Drepanocladus exannulatus* and *Aulacomnium palustre*. An occasional tree of *Larix laricina* occurred on the bog margin.

A second type, THE CAREX – SCIRPUS FEN, was characterized by the presence of sedges and the absence of *Sphagnum*. The dominant species were *Carex limosa*, *C. diandra*, *C. aquatilis*, *Scirpus caespitosus*, *S. hudsonianus* and *Drepanocladus venicosus*. Associated with these species were *Equisetum fluviatile*, *Sparganium minimum*, *Triglochin maritima*, *Carex buxbaumii*, *C. chordorhiza*, *C. livida*, *Eriophorum viridi-carinatum*, *Utricularia intermedia* and *U. vulgaris*.

In the zone between the *Carex – Scirpus* fen and the *Picea mariana* muskeg was a drier, shrubby vegetation characterized by *Scirpus caespitosus* and *S. hudsonianus* and scattered shrubs of *Betula glandulosa*, *Myrica gale*, *Kalmia polifolia*, *Vaccinium uliginosum* and occasional trees of *Larix laricina* and *Picea mariana*. Associated with these species were *Lycopodium selago*, *Triglochin maritima*, *Tofieldia pusilla*, *Salix arctophila*, *S. reticulata*, *Pedicularis labradorica* and *Pinguicula vulgaris*.

PINUS BANKSIANA WOODS. Pure stands of *P. banksiana* were not common and this species was usually associated with *Picea mariana* on eskers, sandy till ridges, old beach lines and in burned areas. A few woods with *P. banksiana* the dominant species were observed in extensive sand blowouts. Here, the trees were widely spaced, the undergrowth was scanty and the forest floor was usually lichen covered. Characteristic species included scattered shrubs of *Betula glandulosa*, *Vaccinium myrtilloides*, *Vaccinium vitis-idaea* and *Ribes*

glandulosum, and the herbs *Carex abdita*, *C. foenea*, *Calamagrostis purpurascens*, *Festuca saximontana*, *Poa pratensis* and *Arnica lonchophylla*.

Putative introgressant forms of *Pinus* are discussed in the catalogue.

Minor Forest Communities

PICEA GLAUCA WOODS. *Picea glauca* is rare in northeastern Saskatchewan and only one stand dominated by *P. glauca* and a possible stand remnant was seen. A small stand of *P. glauca* with associated *P. mariana* and *Larix laricina* was located a few kilometers west of Hasbala Lake. The habitat was wet and the ground moss covered. Common in this stand were *Carex scirpoidea*, *C. vaginata*, *Orchis rotundifolia*, *Salix abrusculoides*, *S. glauca*, *S. myrtillifolia*, *S. reticulata*, *Mitella nuda*, *Rubus acaulis*, *Arctostaphylos alpina* ssp. *rubra* and *Aster hysopifolius*.

A single individual of *Picea glauca*, standing about 5 m tall, was found on a small patch of turf in the middle of a sand blowout within a *Picea mariana* — lichen woods. The size of the tree and the well-developed turf in which it was growing suggested that it represented a relict of a more extensive forest that was destroyed by fire.

My observations on the occurrence of *P. glauca* in northeastern Saskatchewan do not agree with Tyrrell (1898), Ritchie (1959) and Larsen (1965) who maintain that *P. glauca* is the chief tree species on eskers in the subarctic. In this area *P. mariana* is the only species of *Picea* observed on eskers. A possible explanation for this apparent disagreement has been suggested by Ritchie who observed that *P. mariana* occurs on eskers where *P. mariana* forests are contiguous to the eskers, possibly because of the large number of seed parents. In the study area *P. mariana* forests occurred adjacent to the eskers and occupied much of the surrounding till plains. It is also possible that hybridization and introgression between *P. mariana* and *P. glauca*, which has been suspected by Larsen (1965), may result in species misidentification. A study of this possibility as well as further exploration of eskers in northern Saskatchewan is desirable.

Lake Margin Communities

The marginal vegetation of lakes located on glacial till is subdivided, for convenience, into aquatic, *Carex* fen or meadow, *Salix* fen, rocky lake margin and sand beach communities.

The floating AQUATICS *Potemogeton richardsonii*, *P. filiformis*, *P. alpinus* var. *tenuifolia*, *Nuphar variegatum*, *Ranunculus aquatilis* var. *capillaceus* and *Calligeron giganteum* often occurred along lake margins. In shallow water, emergent *Equisetum fluviatile* may form extensive monodominant stands sometimes with *Utricularia intermedia* and *Potentilla palustris*. *Isoetes muricata* var. *braunii* occurred in sand between rocks on the margins of most lakes in the area, especially in protected coves.

CAREX FENS occurred on mucky or peaty lake margins and graded either directly into *Picea mariana* muskeg or through a *Salix* fen to muskeg. Large

Carex fens dominated by *Carex rostrata* or *C. aquatilis* were common. The following species occurred in these fens: *Carex canescens*, *C. paupercula*, *C. physocarpa*, *Eriophorum angustifolium*, *Scirpus hudsonianus*, *Salix arctophila*, *S. glauca*, *S. pedicellaris*, *Cicuta mackenzieana* and *Galium trifidum*.

SALIX PLANIFOLIA FENS with an understory of *Calamagrostis canadensis*, *Carex aquatilis*, *C. physocarpa*, *C. rostrata* and *Veronica scutellata* were common on lake margins. These fens were apparently seasonally flooded, although they were dry on the surface in late summer. Species which also occurred in these fens were *Equisetum arvense*, *Carex brunnescens*, *Eriophorum angustifolium*, *Myrica gale*, *Betula glandulosa*, *Stellaria calycantha*, *Actaea rubra*, *Ribes glandulosa* and *Rubus acaulis*.

ROCKY LAKE MARGINS were sometimes edged with turf shaded by species of *Salix* and the adjacent forest. Habitats of this type on Patterson and Hasbala Lakes supported a number of interesting arctic and subarctic species which were uncommon elsewhere. These included *Juncus filiformis* (dominant), *Selaginella selaginoides*, *Carex garberi*, *Luzula nivalis*, *Salix reticulata*, *Polygonum viviparum*, *Coptis trifolia* var. *groenlandica*, *Parnassia kotzebuei* and *Primula mistassinica*.

SAND BEACHES were uncommon here and occurred only where the lake was eroding a sandy esker or an old bench line. The vegetation on beaches was scanty and included *Equisetum arvense*, *Carex physocarpa*, *Juncus filiformis*, *Ranunculus reptans* and *Rorripa icelandica* var. *fernaldiana*.

Esker Communities

Eskers are a prominent feature of the landscape in northeastern Saskatchewan. They occur as single or multiple ridges separated by elliptical or circular depressions (kettles) or as chains of isolated conical hills (Taylor, 1963). An esker of the multiple ridge type south of Hasbala Lake was visited and a brief visit was made to a single ridge esker near Warren Lake.

The ESKER SLOPES AND SUMMITS were usually covered with open *Picea mariana* – lichen and *P. mariana* – feather moss woods. *Pinus banksiana* occurred on eskers either in association with *Picea mariana* or in small, almost pure stands. *Betula "papyrifera"* occurred on moist slopes in association with *Picea mariana*.

The KETTLES or depressions on and between ridges were dry or held small lakes and ponds. Dry kettles and dry open slopes were dominated by *Cetraria*, *Cladonia* and *Stereocaulon* in association with *Agrostis scabra*, *Calamagrostis inexpansa*, *Festuca saximontana*, *Oryzopsis pungens* and *Poa glauca*. Mats of *Vaccinium vitis-idaea*, *Arctostaphylos uva-ursi*, *Saxifraga tricuspidata* and *Potentilla tridentata* also covered large areas. Here also were *Lycopodium complanatum*, *L. sabinae folium* var. *sitchensis*, *Trisetum spicatum*, *Carex foenea*, *Anemone multifida*, *Erigeron acris* var. *asteroides*, *Antennaria umbrinella*, *Artemisia campestris* var. *borealis* and *Solidago spathulata* var. *neomexicana*.

A stand of dwarfed *Picea mariana* was observed in the bottom of one dry kettle. The trees ranged from 2 to 3 m tall and showed signs of wind pruning. A similar condition was described by Larsen (1965) at Ennadai Lake, N.W.T.

SAND BLOWOUTS were common on sandy eskers but were rarely extensive. Mats of *Empetrum hermaphroditum*, *Potentilla tridentata*, and the trailing rhizomes of *Carex foenea* stabilized the sand. Also occurring in blowouts were *Agrostis scabra*, *Calamagrostis canadensis*, *C. inexpansa*, *C. purpurascens*, *Poa glauca*, *Festuca saximontana*, *Carex bigelowii*, *C. brevipes*, *C. supina* var. *spaniocarpa* and scattered shrubs of *Juniperus communis* var. *depressa*. The margin of one blowout at Warren Lake was occupied by a shrubby growth of *Populus tremuloides* less than 1 m tall.

OPEN SANDY-GRAVEL SURFACES supported such pioneer species as *Rhacomitrium canescens*, *Carex glacialis*, *C. supina* var. *spaniocapa*, *Festuca saximontana* and *Poa glauca*.

Cliff Communities

A GRANITE CLIFF west of Patterson Lake supported a community dominated by scattered trees of *Betula "papyrifera"*, the shrubs *Ledum groenlandicum*, *L. palustre* var. *decumbens*, *Vaccinium uliginosum*, *V. vitis-idaea* and *Rubus idaeus* var. *strigosus*. Other vascular plants collected here were *Empetrum hermaphroditum*, *Ribes glandulosum*, *R. triste*, *Poa glauca* and *Calamagrostis canadensis*. Lichens covering the dry ledges included *Peltigera malacea*, *Cladonia amaurocraea*, *C. alpestris*, *C. alpicola*, *C. cornuta*, *C. rangiferina* and *Actinogyra muhlenbergia*. The fern *Polypodium vulgare* var. *virginiana* formed large colonies in some lichen mats and *Gymnocarpium robertianum* occurred in crevices with mosses. Some wet faces supported dense mats of the mosses *Ulota crispa*, *Cynodontium tenellum* and *Dicranum elongatum*.

Tundra Communities

Tundra vegetation has not been previously described in Saskatchewan. Two communities considered to be tundra because of their treeless condition, arctic taxa and areal extent were studied in the Patterson–Hasbala Lakes region. One was a moist boulder field and the other a dry rock field.

MOIST BOULDER FIELD. A prominent assemblage of arctic and subarctic species was discovered on a boulder field which filled a narrow stream valley south of Hasbala Lake. The boulder field, about 1.5 km long, had a marked gradient and a shallow stream flowing down its centre.

At the upper end of the valley a deep, compact turf over the boulders was covered with a thicket dominated by *Betula glandulosa*, *Vaccinium uliginosum* and *Potentilla fruticosa*. Under these shrubs there was an almost continuous mat of the arctic willows *Salix arctophila* and *S. reticulata*. Scattered in the thicket were *Salix myrtillifolia*, *S. planifolia* and *Myrica gale*. Here also were *Carex norvegica*, *C. scirpoidea*, *C. dioica* ssp. *gynocrates*, *Scirpus caespitosus* var. *callosus* and *Polygonum viviparum*. The arctic-circumpolar

Juncus triglumis ssp. *albescens* occurred here, as in the *Picea mariana* muskeg, on open, hard packed silt frost boils.

Toward the lower end of the valley the turf became thinner and finally disappeared. The vegetation was progressively less dense and finally occurred only in sand-filled cracks and spaces between boulders. *Vaccinium uliginosum* increased in relative abundance over *Betula glandulosa; Salix arctophila* and *S. reticulata* remained prominent and the frequency of *S. glauca* increased. The number of herbaceous species increased downstream and *Equisetum arvense*, *E. scirpoides*, *Agrostis borealis*, *Carex bigelowii*, *C. diandra*, *C. dioica* ssp. *gynocrates*, *C. norvegica*, *C. saxatalis* var. *miliaris*, *C. scirpoidea*, *Polygonum viviparum*, *Anemone parviflora*, *Parnassia multiseta*, *Rubus acaulis*, *Astragalus alpinus*, *Epilobium palustre* and *Galium trifidum* were noted. A small, but conspicuous stand of *Poa alpina* occurred in cracks on a large boulder.

A dense thicket of *Salix planifolia*, *S. serissima* and *Betula glandulosa* 2 to 2.5 m tall occurred directly over the stream. Here the thicket was so dense that the tops of the shrubs could support the weight of a man. Growing in the deep shade beneath this thicket were *Viola palustris* and *Scutellaria galericulata* var. *epilobiifolia*.

DRY ROCK FIELD. Tundra vegetation was observed on the north and northwest sides of the summit of Arctic Butte, a granite hill at 1550 feet elevation located 3.2 km southwest of Patterson Lake. Arctic Butte was covered with red granite rubble and a shallow, coarse-textured soil.

Scattered, stunted individuals of *Picea mariana* and *Betula fontinalis* occurred on the hill, but in general the summit was treeless. The vegetation was dominated by *Empetrum hermaphroditum*, *Vaccinium uliginosum* and *Loiseuleria procumbens*. *Betula glandulosa*, *Pedicularis labradorica*, *Carex capitata* and *Vaccinium vitis-idaea* were common, and the shrubs *Salix bebbiana*, *S. planifolia*, *S. glauca*, *S. arbusculoides*, *Ledum palustre* var. *decumbens* and *Andromeda polifolia* were scattered throughout. Also here were *Carex bigelowii*, *Eriophorum brachyantherum* and *Calamagrostis canadensis*.

The arctic taxa *Carex capitata* and *Luzula confusa* occurred in deeper soil around the base of boulders and *Carex glacialis* occurred only on bare soil near the centre of frost boils. This rock field is similar to those described by Larsen (1965) from the south end of Ennadai Lake, N.W.T.

In subarctic Saskatchewan arctic taxa begin to appear, although infrequently, in both boreal and tundra communities. For example, *Salix reticulata* occurred in a small muskeg at the edge of an esker kettle and in a *Vaccinium uliginosum–Scirpus caespitosus* fen in association with *Salix arctophila*, *Lycopodium selago* and *Pinguicula vulgaris*. *Lycopodium selago* also occurred infrequently in *Picea mariana* muskegs sometimes with *Loiseleuria procumbens* and in wet *Picea mariana–Salix planifolia* woods on stream margins. *Salix arctophila* appeared infrequently in *Carex* fens and in wet drainageways in *Picea mariana* muskegs and *Loiseleuria procumbens* frequently was noted in *Picea mariana*–lichen woods. Arctic taxa also occurred in small numbers in such restricted habitats as rocky lake margins and silt frost boils.

ANNOTATED CATALOGUE OF PLANT SPECIES

The following catalogue contains 203 taxa of vascular plants, 42 bryophytes and 24 lichens. The relatively high number of vascular plants in this area as compared with surrounding areas such as Black Lake, 132 taxa (Scotter, 1961), Big Spruce River, 135 taxa (Ritchie, 1959) and Neultin Lake, 134 taxa (Porsild, 1950) may be a reflection of its transitional subarctic vegetation in which some low arctic species begin to appear and boreal species still persist.

A number of species new to Saskatchewan are reported here, including 13 vascular plants, 15 bryophtes and 1 lichen.

The nomenclature is after Scoggan (1957) except where synonyms are cited.

All specimens have been identified by the author with the exception of the lichens (M. Hale and J. Thomson), bryophytes (H. Crum), Polypodiaceae (R. & A. Tryon), *Isoetes* (C. Reed) and *Betula* (J. Dugle). Other groups were verified by specialists: *Carex* (J. Calder or F. Hermann), *Juncus* (F. Hermann), Compositae (A. Cronquist), Gramineae (W. Dore), *Pinus* (R. Shoenike) and miscellaneous specimens (A. E. Porsild). A complete set of specimens is deposited in the W. P. Fraser Herbarium, University of Saskatchewan.

Abbreviations used in catalogue are: H. L., Hasbala Lake; P. L., Patterson Lake; W. L., Warren Lake. The collection numbers are the author's.

Vascular Plants

EQUISETACEAE

EQUISETUM ARVENSE L. Infrequent on lake shores, sandy beaches, and rocky shores; on mineral soil in *Picea mariana* burns; and in *Betula glandulosa* scrub vegetation. H. L. *259-63;* P. L. *439-63.*

E. FLUVIATILE L. Emergent aquatic on lake margins; infrequent in a wet *Menyanthes-Scirpus* fen. An extensive E. *fluviatile* marsh occurs at the south end of Hasbala Lake. H. L. *881-62, 178-63.*

E. PALUSTRE L. In wet *Picea mariana* woods. H. L. *234-63, 285-63.* A northward extension of the Saskatchewan range of this species (see map 89, Hultén, 1964).

E. SCIRPOIDES Michx. Frequent on compact moss hummocks in *Picea mariana* muskegs and in *P. mariana* burns, on rocky lake shores, and on mineral soil in tundra vegetation. H. L. *852-62, 1029-62, 225-63, 236-63.*

E. SYLVATICUM L. In *Picea mariana* muskeg. H. L. *981-62, 216-63.*

LYCOPODIACEAE

LYCOPODIUM ANNOTINUM L. var. PUNGENS (La Pylaie) Desv. In dry, open *Picea mariana — Betula glandulosa —* lichen woods on esker and on mineral soil in *Picea mariana* burns. H. L. *929-62, 260-63.*

L. CLAVATUM L. In *Picea mariana*—lichen woods. H. L. *1042-62, 263-63.*

L. COMPLANATUM L. Common in *Picea mariana*—lichen woods, dry lichen slopes on eskers, and on dry sandy slopes in *Picea mariana* burns. H. L. *104-63, 145-63.*

L. SABINAEFOLIUM Willd. ssp. SITCHENSE (Rupr.) Calder & Taylor. Common on eskers in *Picea mariana*—lichen woods, on dry sandy slopes, and in *Picea mariana—Larix laricina—Pinus banksiana* woods. H. L. *928-62, 193-63, 485-63.*

This is the second Saskatchewan record for this rarely collected species. It was previously collected by Raup (1936) on Lake Athabasca at the mouth of the William River. It resembles *L. alpinum* L. in its habit and the short sessile strobili (ca. 0.5-0.8 cm long), but differs from that species in lacking flattened dorsiventral branches and trowel-shaped leaves.

L. SELAGO L. Infrequent, but occurring in a variety of habitats from *Picea mariana—Larix laricina* woods on the edge of an esker in association with *L. sabinaefolium* ssp. *sitchense* and *Loiseleuria procumbens*, to a *Scirpus caespitosus—Vaccinium uliginosum*

fen on a pond margin in association with *Pinguicula vulgaris*, *Salix reticulata* and *S. arctophila;* and in a wet stream margin woods. H. L. *191-63*, *194-63*, *316-63*.

This is the second report of this arctic species for Saskatchewan. It was previously collected on the shores of Lake Athabasca (Raup, 1936). Wherever this species was collected it was in association with other arctic species.

SELAGINELLACEAE

SELAGINELLA SELAGINOIDES (L.) Link. Rare, in moss on a rocky lake margin growing under *Salix planifolia* and *Betula glandulosa* in association with *Coptis trifolia* var. *groenlandica*, *Parnassia kotzebuei* and *Primula mistassinica*. P. L. *404-63*.

POLYPODIACEAE

GYMNOCARPIUM ROBERTIANUM (Hoffm.) Newm. In mature streamside *Picea mariana —Betula "papyrifera"* woods, and locally abundant with mosses in crevices on granitic and metamorphic cliffs. H. L. *895-62*, *227-63;* P. L. *361-63*, *456-63*.

POLYPODIUM VULGARE L. var. VIRGINIANUM (L.) Eaton. Seen only as a large colony growing in a *Cladonia rangiferina*, *C. cornuta* mat on a granite block at the base of a cliff. P. L. *464-63*.

WOODSIA GLABELLA R. Br. In crevices on an outcrop in *Picea mariana* woods, and in crevices on a metamorphic cliff. H. L. *226-63*, *239-63*.

ISOETACEAE

ISOETES MURICATA Dur. var. BRAUNII (Dm.) Reed. Rarely collected but widely distributed in lakes in northeastern Saskatchewan. Usually growing in sand in water 7-30 cm deep. H. L. *1044-62;* P. L. *405-63*, *432-63;* W. L. *611-63*.

PINACEAE

JUNIPERUS COMMUNIS L. var. DEPRESSA Pursh. Occasional in dry *Picea mariana*—lichen woods and in blowouts in *Pinus banksiana—Picea mariana* woods on sandy eskers. Most commonly seen on dry south-facing outcrops. H. L. *1013-62*, *237-63*.

LARIX LARICINA (Du Roi) K. Koch. A relatively uncommon species, collected from the margin of a *Sphagnum* bog and on the margin of an island in Hasbala Lake. This species has been observed in the transitional area between *Picea mariana* muskeg and *P. mariana*—feather moss woods. H. L. *1051-62*, *235-63*.

PICEA GLAUCA (Moench) Voss. The least common conifer in northeastern Saskatchewan. Only two stands observed, one consisting of a single tree, 15 feet tall, growing on a patch of turf in a blowout in a *Picea mariana* woods on a sandy esker (H. L. *199-63*) and the other a small stand in a wet *Picea glauca — P. mariana — Larix laricina* woods.

PICEA MARIANA (Mill.) BSP. The dominant conifer in the study area, occupying a wide variety of habitats from dry ridge tops and esker summits to wet muskegs and *Sphagnum* bogs. On very sandy sites it is often accompanied by or replaced by *Pinus banksiana*. H. L. *995-62*, *996-62*, *1039-62;* W. L. *607-63*.

PINUS BANKSIANA Lamb. A relatively common tree species on sandy sites where it may form almost monodominant stands (H. L. *1004-62*, *303-63A*). It also occurs in open *Picea mariana*—lichen woods on summits and sandy parts of eskers (H. L. *822-62*, *932-62*).

Some individuals referrable to *P. banksiana* (*cf.*, population sample *1004-62*, specimen *303-63A* and other collections from northern Saskatchewan) show some *P. contorta*-like characteristics including umbos with prominent and persistent spines, divergent cone axes and longer than average needles. *Pinus contorta* does not now occur in boreal Saskatchewan (known in Saskatchewan only from Cypress Hills) and the problem of explaining the presence of these characters in northeastern Saskatchewan is an interesting one. The evidence for introgression between *P. banksiana* and *P. contorta* in Saskatchewan is being assembled and it will appear in a separate paper.

SPARGANIACEAE

SPARGANIUM ANGUSTIFOLIUM Michx. Seen only once floating in a sluggish stream. H. L. *920-62*.

S. MINIMUM (Hartm.) Fries. In shallow, sluggish water at edge of small lake and in very wet *Carex—Menyanthes* fens. H. L. *883-62*, *134-63*; P. L. *429-63*.

POTAMOGETONACEAE

POTAMOGETON ALPINUS Balbis var. TENUIFOLIUS (Raf.) Ogden. Floating in fast-flowing streams and in shallow water on lake margins. H. L. *884-62*, *246-63*; P. L. *420-63*.

P. FILIFORMIS Pers. var. BOREALIS (Raf.) St. John. Growing in shallow water at lake edge in sandy-gravel substrate. H. L. *1045-62*.

This report is an extension of the range of this species into northern Sakatchewan.

P. RICHARDSONII (Benn.) Rydb. Occurs in fast-flowing streams and lakes in water 0.3 to 2 m deep. H. L. *885-62, 247-63, 350-63*.

JUNCAGINACEAE

TRIGLOCHIN MARITIMA L. On wet pond margins in a *Scirpus—Menyanthes* fen, and in *Carex aquatilis—C. livida—Scirpus* fens. H. L. *135-63, 180-63, 184-63*; P. L. *482-63*.

GRAMINEAE

AGROPYRON TRACHYCAULUM (Link.) Malte var. NOVAE-ANGLIAE (Scribner.) Fern. A rare species in this area. Encountered only twice, once on the south-facing sandy slope of an esker associated with *Populus balsmifera* and again in a wet drainage area in a *Picea mariana* muskeg. H. L. *320-63*; P. L. *445-63*.

AGROSTIS BOREALIS Hartm. Common in the tundra on the moist boulder field, in *Salix* thickets, and on rocky lake shores. H. L. *1027-62, 1028-62, 340-63, 358-63*; P. L. *396-63*.

A. SCABRA Willd. Common in dry habitats including blowouts in *Pinus banksiana—Picea mariana* woods, dry depressions on eskers, on a beaver house, and on sand in partly burned *Pinus banksiana* woods. A meadow dominated by this species associated with dwarfed *Picea mariana* was observed on a sandy esker at Warren Lake. H. L. *915-62, 926-62, 1008-62, 304-63A;* W. L. *602-63*.

CALAMAGROSTIS CANADENSIS (Michx.) Beauv. Occupies a wide variety of habitats from *Picea mariana*—lichen woods to *Picea mariana* muskeg, sand blowouts in *Pinus banksiana* woods, granitic cliffs, rich graminoid—*Salix* thickets and the moist boulder field and dry rock field tundra. H. L. *949-62, 819-62, 1010-62, 863-62, 220-63;* P. L. *377-63, 379-63A, 422-63, 428-63, 431-63, 450-63*.

Two specimens have been referred to var. *langsdorfii* (Link.) Hult., *422-63, 949-62*. The variation in this species is confusing and the two specimens from the dry rock field tundra on Arctic Butte, *377-63* and *379-63A*, have been apparently so modified by their environment that they are not readily distinguishable as the species.

C. INEXPANSA Gray. Occurs in *Picea mariana*—lichen woods on eskers, in *Picea mariana* muskegs, among boulders on stream margins, and in an *Agrostis scabra* meadow. H. L. *820-62, 848-62, 871-62;* P. L. *427-63, 446-63;* W. L. *603-63*.

C. PURPURASCENS R. Br. On sandy eskers, blowouts in *Pinus banksiana—Picea mariana* woods and in *P. mariana* burns on sandy soils. H. L. *1000-62, 1009-62, 105-63;* W. L. *591-63*.

FESTUCA SAXIMONTANA Rydb. Apparently restricted to eskers where it occurs on open sandy-gravel slopes, sand blowouts, and in an *Agrostis scabra* meadow. H. L. *1005-62, 302-63A;* W. L. *598-63, 606-63*.

ORYZOPSIS PUNGENS (Torr.) Hitchc. In *Picea mariana*—lichen woods and dry depressions on eskers. H. L. *927-62, 970-62, 484-63*.

POA ALPINA L. Seen only in the tundra vegetation on the moist boulder field south of Hasbala Lake in sand on and between boulders. H. L. *1025-62, 330-63*.

This is the second report of this species for Saskatchewan. It was previously collected by Raup (1936) on the north shore of Lake Athabasca.

P. GLAUCA Vahl. Frequent in dry habitats including sandy eskers, mineral soil in *Picea mariana* burns, granitic and metamorphic cliffs, and open *Picea mariana*—lichen woods on eskers. H. L. *125-63, 202-63, 229-63, 233-63, 305-63, 833-63;* P. L. *362-63, 457-63;* W. L. *593-63, 596-63*.

TRISETUM SPICATUM (L.) Richter ssp. MOLLE (Michx.) Hult. In dry habitats on sandy eskers and in a *Picea mariana* burn. H. L. *925-62, 305-63A, 143-63*.

CYPERACEAE

CAREX ABDITA Bickn. A pioneer on sand blowouts in *Pinus banksiana—Picea mariana* esker woods, and on open sand in *Picea mariana* burns. H. L. *1006-62, 1014-62, 160-63, 306-63*.

New to the flora of Saskatchewan and representing a considerable northward extension of the range of this transcontinental temperate species. Reported by Ritchie (1956) from a similar habitat at Tod Lake, Manitoba about 400 km south of Hasbala Lake.

Some of this material was first identified as the closely related cordilleran species *C. brevipes*. However, it is probably best to refer this material to the transcontinental *C. abdita*, as suggested by Dr. J. Calder (personal communication). The taxonomy of this and the related taxa, *C. rossii, C. umbellata, C. tonsa, C. deflexa*, and *C. brevipes*, is in need of revision.

C. AENEA Fern. In *Picea mariana—Pinus banksiana* burn regeneration on a till ridge. H. L. *106-63*.

C. AQUATILIS Wahl. Dominant in *Carex—Scirpus* fens and present on lake shores in wet drainage ways in *Picea mariana* woods. H. L. *174-63, 244-63;* P. L. *392-63, 444-63* (the latter specimen is immature but near *C. aquatilis*).

C. BICOLOR All. Seen only once on a hard silt frost boil in a *Picea mariana* muskeg. H. L. *269-63*.

A rarely collected arctic—subarctic species new to the flora of Saskatchewan. It is principally a coastal species known, to the east, from Churchill (Scoggan, 1957) and, to the northwest, from Great Bear Lake and Bathurst Inlet (Porsild, 1957, Map. 83).

C. BIGELOWII Torr. Infrequent in the tundra on the moist boulder field and on the dry rock field, and a member of the pioneer, sand-stabilizing communities on sand blowouts. H. L. *1026-62, 325-63, 342-63, 286-63;* P. L. *374-63, 379-63;* W. L. *608-63*.

New to the flora of Saskatchewan but previously reported from several arctic (Scoggan, 1957) and subarctic (Ritchie, 1959) localities in Manitoba.

C. BRUNNESCENS (Pers.) Poir. A member of moist streamside and rocky lake margin communities. Seen also on *Sphagnum* in a wet muskeg meadow. H. L. *977-62, 108-63, 250-63;* P. L. *397-63*.

C. BUXBAUMII Wahl. In wet *Carex—Scirpus* fens. H. L. *176-63*.

C. CANESCENS L. Seen only once in a *Carex* fen associated with *Eriophorum angustifolium*. H. L. *865-62*.

C. CAPILLARIS L. ssp. CHLOROSTACHYS (Stevens) Löve. Infrequent on lake and stream margins, in wet drainage ways in *Picea mariana* muskegs and in tundra on the moist boulder field. H. L. *859-62, 356-63;* P. L. *393-63, 447-63*.

C. CAPITATA L. Common in the tundra on the dry rock field. P. L. *372-63*.

C. CHORDORRHIZA Ehrh. ex L. f. Seen only in a *Carex—Scirpus* fen. P. L. *481-63*.

C. DEFLEXA Hornem. In a rich *Salix—Carex—Calamagrostis* thicket at the edge of a *Picea mariana* muskeg and in a *P. mariana* burn on a sandy esker. H. L. *979-62, 197-63*.

C. DIANDRA Schrank. Occurs on the margin of a wet depression in a *Picea mariana* muskeg and in the tundra on the moist boulder field. H. L. *322-63;* P. L. *477-63*.

C. DIOICA L. ssp. GYNOCRATES (Wormskj.) Hult. In *Picea mariana* muskegs and associated with *Vaccinium uliginosum, Betula glandulosa* and *Potentilla fruticosa* on the moist boulder field. H. L. *853-62, 346-63*.

C. FOENEA Willd. Common in dry sandy habitats, sand blowouts, *Picea mariana*—lichen woods, lichen-covered depressions on eskers, dry slopes in *Picea mariana* burns, and in an *Agrostis* meadow on an esker. H. L. *831-62, 931-62, 935-62, 1007-62;* W. L. *601-63*.

C. GARBERI Fern. (*C. hassei* in Breitung, 1957). Seen only once in moss on a rocky lake shore, associated with *Parnassia kotzebuei*. P. L. *394-63*.

C. GLACIALIS Mack. In the tundra on the dry rock field growing on the mineral soil in a frost boil. Also seen as a pioneer on open sandy gravel on an esker associated with *C. supina*. P. L. *378-63, 382-63;* W. L. *595-63*.

An uncommon species in Saskatchewan reported previously by Raup (1936) from a dolomitic ledge on the north shore of Lake Athabasca. This usually calcicolous species (Gjaervoll, 1958; Raup, 1936) was collected from a granite outcrop.

C. INTERIOR Bailey. Seen only once growing on an outcrop in "Quillwort" Lake. H. L. *892-62*.

C. LEPTALEA Wahl. In wet depressions and drainage ways in *Picea mariana* muskegs and on stream margins. H. L. *845-62, 847-62, 357-63;* P. L. *419-63*.

C. LIMOSA L. One of the mat-forming species in *Sphagnum* bogs, muskeg pools, and *Carex aquatilis—Scirpus* fens. H. L. *1050-62, 256-63;* P. L. *478-63*.

C. LIVIDA (Wahl.) Willd. Collected only once in a *Carex—Scirpus* fen. H. L. *181-63*

C. LOLIACEA L. Scattered in *Hylocomium splendens* in a wet drainage way in a *Picea mariana* muskeg. P. L. *418-63*.

C. MAGELLANICA Lam. (*C. paupercula* Michx.) In wet *Sphagnum*-filled depressions in *Picea mariana* muskegs and in a *Sphagnum, Carex* meadow on a stream margin. H. L. *876-62, 256-63A, 295-63*.

In using this name I am following Hultén (1942) and Calder (personal communication) who maintain that the North American *C. paupercula* cannot be clearly distinguished from the Southern Hemisphere *C. magellanica*.

C. NORVEGICA Retz. On frost hummocks and on sand between boulders in shrubby tundra on the moist boulder field. Also scattered in *Hylocomium splendens* in a wet

drainage way in a *Picea mariana* muskeg and in dry *Picea mariana*—lichen woods on a granite outcrop. H. L. *862-62, 213-63, 329-63, 347-63;* P. L. *417-63.*

C. ROSTRATA Stokes. A common species, dominant in large meadows in shallow water on lake margins. H. L. *919-62;* P. L. *440-63.*

C. SAXATILIS L. ssp. LAXA Kalela (*C. physocarpa* Presl., *C. saxatilis* var. *major* Olney). Found in lake margin habitats including a *Picea mariana* muskeg, a *Carex rostrata* fen, a *Salix, Carex, Calamagrostis* fen, between rocks in shallow water and on a sandy beach. H. L. *867-62, 918-62, 973-62, 112-63, 245-63.*

For a discussion of *Carex physocarpa* and its relationship to *C. saxatilis* see Gjaervoll, 1958, Hultén, 1964 and Scoggan, 1957. These taxa are apparently confluent and the former is distinguished from the latter only by its more robust habit and the dropping pistillate spikes. I am following Hultén in treating *C. physocarpa* as *C. saxatilis* ssp. *laxa.*

C. SAXATILIS L. var. MILIARIS (Michx.) Bailey. On sand among boulders in the tundra on the moist boulder field, and on a sandy beach at the edge of *Picea mariana*—lichen woods. H. L. *328-63, 341-63;* P. L. *435-63.*

C. SCIRPOIDEA Michx. In tundra on the moist boulder field and in wet depressions and drainage ways in *Picea mariana* muskegs. H. L. *842-62, 843-62, 327-63, 339-63, 172-63;* P. L. *443-63.*

C. SUPINA Willd. ex Wahl. ssp. SPANIOCARPA (Steud.) Hult. Seen only as a pioneer on open sand and sandy-gravel slopes on an esker, associated with *C. glacialis* and *C. bigelowii.* W. L. *594-63, 609-63.*

C. VAGINATA Tauscher. In wet drainage ways in *Picea mariana* muskegs. H. L. *169-63, 309-63;* P. L. *444-63A.*

ERIOPHORUM ALPINUM L. (*Scirpus hudsonianus* (Michx.) Fern.). Associated with *Scirpus caespitosus* on margins of muskeg pools and in *Carex—Scirpus* fens. A dominant in a *Carex* meadow on a bog island. H. L. *891-62, 192-63A;* P. L. *476-63.*

E. ANGUSTIFOLIUM Honck. ssp. SUBARCTICUM (Vassil.) Hult. (var. *majus* Schultz). In wet *Carex* meadow, *Carex Sphagnum* depressions in *Picea mariana* muskegs, and at stream edge in tundra on the moist boulder field. H. L. *864-62, 978-62, 248-63, 332-63.*

E. BRACHYANTHERUM Trautv. Seen only twice, once in tundra on the dry rock field west of Patterson Lake and again, in a *Picea mariana* muskeg. H. L. *117-63;* P. L. *370-63.*

E. CHAMISSONIS Mey. Collected in a *Carex rostrata* fen on a lake margin and in a *Sphagnum* bog. H. L. *916-62, 1047-62.*

E. VAGINATUM L. Forming tussocks in wet *Sphagnum* depressions in a *Picea mariana* muskeg. H. L. *298-63.*

E. VIRIDICARINATUM (Engelm.) Fern. In a *Carex—Scirpus* fen. H. L. *177-63.*

SCIRPUS CAESPITOSUS L. var. CALLOSUS Bigel. Dominant in *Carex—Scirpus* fens, common on the margins of muskeg pools, and in the tundra on the moist boulder field. H. L. *840-62;* P. L. *434-63.*

ARACEAE

CALLA PALUSTRIS L. Local in *Carex* meadows and on the wet margin of a beaver pond. H. L. *882-62;* P. L. *470-63.*

JUNCACEAE

JUNCUS TRIGLUMIS L. ssp. ALBESCENS (Lange) Hult. (*J. albescens* (Lange) Fern.). A pioneer species on hard silt frost boils in drainage channels in *Picea mariana* muskegs and in the tundra on the moist boulder field. H. L. *846-62, 348-63, 220-63A, 433-63.*

New to the flora of Saskatchewan. This record represents a southern extension of the range of this arctic-circumpolar taxon. It has been reported as rare and restricted to frost-disturbed habitats in northern Manitoba by Ritchie (1959) and Scoggan (1957).

The taxonomic relationship of *Juncus albescens* and *J. triglumis* has been discussed by several authors. Scandinavian taxonomists (Hultén, 1943; Gjaervoll, 1958) generally regard them as conspecific, whereas, North American taxonomists (Fernald, 1924; Porsild, 1939; Scoggan, 1957) regard them as distinct species. There is no doubt that these taxa are closely related and Hultén's decision to treat them as subspecies (1964) seems to be appropriate. He proposes the taxon ssp. *albescens,* for the "Greenland-American eastern Asiatic type, characterized by shorter capsules . . .", and also paler bracts and perianth, and taller culms.

J. CASTANEUS J. E. Sm. Collected once on a hard silt frost boil in a *Picea mariana* muskeg. H. L. *121-63.*

New to the flora of Saskatchewan but not unexpected in view of its occurrence in Manitoba (Scoggan, 1957), Alberta (Moss, 1959), and the Northwest Territories (Thieret, 1963).

J. FILIFORMIS L. Locally abundant in sand between rocks on a lake shore and on a sandy beach. H. L. *113-63;* P. L. *389-63.*

TUZULA CONFUSA Lindb. Rare, but locally abundant in the tundra on the dry rock field on Arctic Butte. P. L. *373-63.*

An arctic circumpolar taxon new to the flora of Saskatchewan. Known from heath and barrens communities in northern Manitoba (Ritchie, 1959) and the Northwest Territories (Porsild, 1950). It is characterized by a single compact head and channeled, subulate-tipped leaves which are purplish at the base.

L. PARVIFLORA (Ehrh.) Desv. Local in *Picea mariana* muskegs and with *Salix* spp. on moist slopes along lake edge. H. L. *824-62, 940-62, 118-63, 151-63.*

L. NIVALIS (Laest.) Beurl. Rare in moss on a rocky lake margin, and in a *Picea mariana* muskeg. P. L. *388-63, 395-63.*

This report of *Luzula nivalis* for northeastern Saskatchewan is not only a new species for the Province but a remarkable southward extension of the range of this high-arctic species. It was seen twice, once on a rocky lake margin growing in association with other rare or uncommon species which reach the arctic, including *Parnassia kotzebuei, Selaginella selaginoides, Polygonum viviparum* and *Primula mistassinica,* all growing in the shade of *Salix planifolia* and *Betula glandulosa,* and a second time as a single individual in a *Picea mariana* muskeg.

These specimens compare favorably with material of *Luzula nivalis* from Banks Island and Southampton Island. The inflorescence is a single compact head with a bract equaling but not exceeding the inflorescence. The leaves are flat, 2-2.5 mm broad, with blunt callus tips and the basal leaves are brown at the base.

LILIACEAE

SMILACINA TRIFOLIA (L.) Desf. On *Sphagnum* hummocks and in wet depressions in *Picea mariana* muskegs. H. L. *871-62, 893-62, 251-63;* P. L. *407-63.*

TOFIELDIA PUSILLA (Michx.) Pers. In *Picea mariana* muskegs on hard silt frost boils and in wet drainage ways and in a *Scirpus caespitosus—Vaccinium uliginosum* fen. H. L. *873-62, 120-63, 182-63;* P. L. *448-63.*

New to the flora of Saskatchewan but noted by Breitung (1957), (as *T. palustris* Huds.), to be expected in ". . . the extreme northern part of Saskatchewan." It has previously been reported by Raup (1936) from northeastern Alberta (Sand Pt., Lake Athabasca), by Porsild (1950) and Baldwin (1953) from Nueltin Lake, N.W.T., and from Kasmere Lake (Scotter, 1965) and Seal River (Ritchie, 1959) in northern Manitoba.

ORCHIDACEAE

CORALLORHIZA TRIFIDA Chat. Rare, seen only once in a *Picea mariana* muskeg. P. L. *424-63.*

CYPRIPEDIUM PASSERINUM Richards. Collected once in a *Picea mariana* muskeg with *Spiranthes* and *Habenaria.* H. L. *218-63.*

HABENARIA HYPERBOREA (L.) R. Br. Uncommon in *Picea mariana* muskegs and in *Carex—Scirpus* fens. H. L. *179-63, 217-63A.*

ORCHIS ROTUNDIFOLIA Banks. Encountered only once scattered in mosses in a mixed *Picea glauca—P. mariana—Larix laricina* woods. H. L. *170-63.*

SPIRANTHES ROMANZOFFIANA Cham. Local in *Picea mariana* muskegs. H. L. *855-62, 217-63.*

SALICACEAE

POPULUS BALSAMIFERA L. Seen only on a sandy, dry, south-facing esker slope. Several individuals were present but all had been cut to the base by beavers and were regenerating by suckering. H. L. *319-63.*

Observed here near the northern limit of the species.

P. TREMULOIDES Michx. Seen only once forming a low thicket around the margin of a sand blowout on an esker at Warren Lake. There were no shoots taller than 1 m and all shoots were vegetative. W. L. *600-63.*

Occurring here near its northern limit. Observations concerning the shrubby habit of aspen near the northern edge of its range have been made by Tyrrell (1898) and Ritchie (1959).

SALIX ARBUSCULOIDES Anderss. Infrequent in *Picea mariana* muskegs, streamside woods, *Picea mariana*—lichen woods and in tundra communities. H. L. *870-62, 900-62, 1033-62, 124-63, 311-63;* P. L. *365-63, 386-63.*

A widely distributed species occurring as individuals rather than in stands. Shrub height varies from 3 to 7 m on wet streamsides, and 0.3 to 1 m in dry or tundra situations.

S. ARCTOPHILA Cock. ex Heller. Common in the tundra and the *Betula glandulosa—Vaccinium uliginosum* scrub on the moist boulder field. Seen rarely in other habitats including a *Scirpus—Vaccinium* fen, a *Carex*

fen, and in a wet drainage way in a *Picea mariana* muskeg. H. L. *837-62, 877-62, 1030-62, 1036-62, 1037-62, 189-63, 190-63, 323-63, 336-63;* P. L. *442-63.*

New to the flora of Saskatchewan. *Salix arctophila* is an arctic taxon closely related to *S. arctica* Pall. neither of which has been known to occur in Saskatchewan. The ranges of these taxa overlap in northcentral Northwest Territories (see Raup, 1959, Map 7) and their apparent intergradation in this area has led Drury (1962) to consider them as conspecific. My experience with both of these taxa in regions outside of the zone of overlap supports maintaining them as separate species until a comprehensive study can be made.

Outside the zone of overlap these species can be distinguished as follows:

S. arctophila

1. Branchlets green, slender and trailing.
2. Stems and leaves glabrous (except the proximal leaves).
3. Nectaries short, about ½ the length of the pedicels.
4. Ovaries clothed with flat trichomes which refract light into a spectrum.

S. arctica

1. Branchlets and branches usually stout and prostrate, not conspicuously trailing.
2. Stems and leaves more or less pubescent, mature distal leaves "bearded" with a tuft of straight trichomes.
3. Nectaries longer than the pedicels.
4. Ovaries densely clothed with terete, nonrefractive trichomes.

There is little doubt that these taxa do intergrade within the area of overlap and a thorough study may support Drury's opinion, but the "typical" forms are distinct enough to be maintained until the necessary study is made.

S. BEBBIANA Sarg. Common on dry esker slopes and in *Picea mariana–Betula "papyrifera"* woods on thin soil overlying granitic outcrops. Infrequent on lake margins and in the tundra on the dry rock field. H. L. *937-62, 366-63;* P. L. *468-63; W. L. 590-63.*

This is a minor northeastern extension of the range of this species. Map 21 in Raup (1959) should be amended accordingly.

S. CANDIDA Fluegge ex Willd. Rare. Observed only twice, once on a rocky lake shore, and a second time on a *Sphagnum* hummock in a very wet *Carex* meadow. H. L. *221-63, 283-63.*

This species is usually confined to calcareous or alkaline habitats (Argus, 1964b, Raup, 1959) and is uncommon on the Precambrian Shield. This locality is near the northern limit of the range of the species.

S. GLAUCA L. Frequent as individuals in *Picea mariana* muskegs, *P. mariana*—feather moss and summit woods on eskers, in streamside and lake margin vegetation associated with *Salix planifola*, in dry *Picea mariana*—lichen woods on granitic outcrops, and in the tundra on the moist boulder field and the dry rock field. H. L. *854-62, 939-62, 997-62, 1031-62, 1034-62, 1035-62, 116-63, 152-63, 153-63, 155-63, 156-63, 307-63A, 331-63, 353-63;* P. L. *363-63, 364-63, 371-63, 383-63, 384-63, 385-63, 423-63, 436-63, 437-63, 469-63.*

S. MYRTILLIFOLIA Anderss. Infrequent in *Picea mariana* muskegs, in deep turf under *Betula glandulosa* on the moist boulder field, and on lake margins. H. L. *850-62, 150-63, 243-63.*

Only the "typical" form of the species with a decumbent, spreading habit was encountered in this area. Northeastern Saskatchewan is very near the northern edge of the range of this boreal forest species.

S. PEDICELLARIS Pursh (including var. *hypoglauca* Fern.). Uncommon, restricted to wet *Carex* fens, wet *Sphagnum*-filled depressions in *Picea mariana* woods, and *Sphagnum* bogs. H. L. *875-62, 1048-62, 131-63, 254-63;* P. L. *472-63, 479-63.*

Near the northern limit of the range of this species. Map 23 Raup, 1959, should be amended to include northeastern Saskatchewan.

S. PEDICELLARIS Pursh X PLANIFOLIA Pursh. Specimens representing this hybrid, or perhaps *S. glauca* X *planifolia* have been collected in several habitats. This material will be considered in a separate paper.

S. PLANIFOLIA Pursh. This is the most important species of willow in northeastern Saskatchewan, and is often dominant in moist or wet habitats. It has been observed in *Picea mariana* muskegs, *P. mariana*—lichen woods, *Scirpus* fens, in streamside and lakeshore vegetation, and in the tundra on the moist boulder field and the dry rock field. It is frequently the dominant in *Salix* scrub communities on lake margins. H. L. *901-62, 944-62, 1032-62, 253-63, 282-63, 284-63, 352-63;* P. L. *368-63, 438-63.*

S. PYRIFOLIA Anderss. Uncommon in *Picea mariana* woods and in rubble at the base of granitic cliffs. It was a dominant in a willow

thicket on the margin of a *Carex* fen at Warren Lake, but not observed in similar habitats elsewhere. P. L. *360-63, 430-63;* W. L. *610-63.*

S. RETICULATA L. Infrequent in *Picea mariana* muskegs, *P. mariana* mixed woods, *Vaccinium uliginosum—Scirpus* fens and on rocky lake shores. Common in the tundra on the moist boulder field. H. L. *823-62, 838-62, 1024-62, 149-63, 186-63, 276-63; P. L. 387-63.*

New to the flora of Saskatchewan and a marked southern extension of the range of this arctic-alpine species (Map 3, Raup, 1959, should be amended accordingly). In view of its relative importance in this region and the variety of habitats that it occupies it is expected to occur in similar subarctic habitats further southward and westward.

S. SERISSIMA (Bailey) Fern. Rare, but locally abundant in a thicket covering a boulder-choked stream. H. L. *860-62, 335-63.*

This species forms a dense thicket in association with *Betula glandulosa* and *Salix planifolia* over a stream flowing through the moist boulder field south of Hasbala Lake. This sterile, but vegetatively vigorous, population was observed for two years but no flowers or fruits were noted. This report represents a northeastward extension of the species range. Map 1 in Raup, 1959, should be amended to include this area.

MYRICACEAE

MYRICA GALE L. Occurs in *Carex—Scirpus* fens, under *Salix* on rocky lake shores, and in the tundra on the moist boulder field. H. L. *835-62, 188-63.*

BETULACEAE[1]

ALNUS CRISPA (Ait.) Pursh. Infrequent on lake shores and in *Picea mariana* burn regeneration on sandy eskers. H. L. *938-62, 1003-62, 157-63.*

BETULA FONTINALIS Sarg. Collected only in the tundra on the dry rock field. P. L. *381-62.* Several putative hybrids involving this species were collected on the eskers at Hasbala Lake and presumably this species could be expected there also.

Reported (as *B. occidentalis*) in a similar tundra habitat at Nueltin Lake by Porsild, 1950.

B. FONTINALIS Sarg. X GLANDULOSA Michx. (*B.* X *eastwoodae* Sarg.). In *Picea mariana*—lichen woods on esker and in the tundra on the dry rock field. H. L. *1062-62, 122-63, 123-63;* P. L. *367-63.*

B. GLANDULOSA Michx. Common in *Picea mariana*—lichen and feathermoss woods, dry lichen-covered slopes on eskers, *P. mariana* muskegs, *Carex—Scirpus* fens and tundra vegetation on the moist boulder field and on the dry rock field. H. L. *844-62, 1061-62, 1063-62.*

B. PAPYRIFERA Marsh X RESINIFERA Brit. (*B.* X *winteri* Dugle). On a sandy esker. W. L. *589-63.*

B. RESINIFERA Brit. Collected in *Picea mariana*—lichen woods on eskers and from the base of a granite cliff. H. L. *1064-62;* P. L. *463-63.*

POLYGONACEAE

POLYGONUM VIVIPARUM L. Rare in a *Betula glandulosa—Vaccinium uliginosum* thicket on the moist boulder field and in mossy turf in a muskeg at lake edge. H. L. *851-62, 114-63, 345-63.*

Specimen *345-63* is floriferous at the apex and bulbiferous at the base, *851-62* is mixed and *114-63* is all bulbiferous.

New to the flora of Saskatchewan. This by Raup (1936), as indicated by Breitung (1957), but from Great Slave Lake and Calumet, Alberta, on the Athabasca River. This arctic—alpine species occurred only as rare, scattered individuals in mosses.

CARYOPHYLLACEAE

ARENARIA MACROPHYLLA Hook. Seen once in a *Picea mariana* burn. H. L. *147-63.*

This species is apparently uncommon in northern Saskatchewan and has been previously reported only from Lake Athabasca (Raup, 1936).

A. STRICTA Michx. ssp. DAWSONENSIS (Britt.) Maguire. Occurs on dry slopes of sandy eskers and in the shrubby tundra on the moist boulder field. H. L. *1020-62, 1058-62, 198-63.*

CERASTIUM ALPINUM L. var. STRIGOSUM Hult. Seen only in a burned *Picea mariana*—lichen woods. H. L. *207-63.*

New to the flora of Saskatchewan and a southern extension of the range of this arctic taxon (*see* Hultén, 1956, Fig. 4).

[1]*Betula* was identified by Dr. Janet Dugle, Osborn Botanical Laboratory, Yale University, New Haven, Conn., and the names used here follow her nomenclature. The absence of *B. papyrifera* from this collection probably reflects the insufficient collection of the genus from northeastern Saskatchewan. The genus *Betula* in northern Saskatchewan is very complex and deserves a thorough investigation.

STELLARIA CALYCANTHA (Ledeb.) Bong. In *Picea mariana* muskegs and in rich *Salix—Calamagrostis* vegetation along a stream. H. L. *948-62, 219-63.*

S. LONGIFOLIA Muhl. ex Willd. In *Picea mariana* muskegs and *Salix planifolia* thickets on stream margins. H. L. *115-63, 257-63, 354-63.*

NYMPHAEACEAE

NUPHAR VARIEGATUM Englem. Locally abundant in shallow lakes and sluggish streams. H. L. *921-62, 922-62.*

RANUNCULACEAE

ACTAEA RUBRA (Ait.) Willd. Rare. Collected in a rich *Salix—Calamagrostis* community on a stream margin. H. L. *947-62.*

ANEMONE MULTIFIDA Poir. Rare, known only from dry lichen covered depressions on an esker. H. L. *826-62, 827-62.*

A. PARVIFLORA Michx. Uncommon, in a burned *Picea mariana*—lichen woods, and in the tundra on the moist boulder field where it was growing in sand between boulders. H. L. *1017-62, 209-63, 326-63.*

Rare in northern Saskatchewan; previously reported in Saskatchewan from wet limestone cliffs at Carswell Lake (Argus, 1964a).

COPTIS TRIFOLIA (L.) Salisb. var. GROENLANDICA (Oeder) Fassett. Rare. Seen only on rocky lake margins in association with *Parnassia kotzebuei, Primula mistassinica, Selaginella selaginoides* and other rare species. P. L. *403-63.*

RANUNCULUS AQUATILIS L. var. CAPILLACEUS (Thuill.) DC. An infrequent aquatic in shallow lakes and streams. H. L. *887-62, 349-63.*

R. LAPPONICUS L. Rare. Seen only once in a *Hylocomium splendens* mat in a wet drainage way in a *Picea mariana* woods. P. L. *410-63.*

R. REPTANS L. (*R. flammula* L. var. *ovalis* (Bigel.) Benson). On sandy beaches and in *Sphagnum* in wet *Picea mariana* muskegs. H. L. *110-63, 258-63.*

PAPAVERACEAE

CORYDALIS SEMPERVIRENS (L.) Pers. Collected only in a *Picea mariana* burn. H. L. *144-63.*

CRUCIFERAE

DRABA CINEREA Adams. Seen only on a dry metamorphic cliff. H. L. *231-63.*

An arctic—circumpolar species rarely collected this far south. Represented in this general region by collections from Lake Athabasca (Raup, 1936) and Churchill (Ritchie, 1956).

RORRIPA ICELANDICA (Oeder) Barbas var. FERNALDIANA Butt. & Abbe. On sandy beaches and in wet moss on lake edges. H. L. *111-63, 166-63.*

DROSERACEAE

DROSERA ANGLICA Huds. Infrequent in *Sphagnum* bogs, and *Carex—Scirpus* fens. H. L. *1046-62, 175-63;* P. L. *480-63.*

SAXIFRAGACEAE

MITELLA NUDA L. Uncommon, in mixed *Picea glauca—P. mariana—Larix laricina* woods, *Picea mariana—Betula "papyrifera"* woods and in moss on rocky lake shores. H. L. *898-62, 172-63;* P. L. *400-63.*

PARNASSIA KOTZEBUEI Cham. Rare, seen only in moss on a rocky lake shore with other rare species including *Primula mistassinica, Carex garberi, Luzula nivalis, Selginella selaginoides, et al.* P. L. *401-63.*

P. MULTISETA (Ledeb.) Fern. (*P. palustris* L. ssp. *neogaea*). In *Picea mariana* muskeg and the tundra on the moist boulder field. H. L. *879-62, 1019-62;* P. L. *402-63.*

RIBES GLANDULOSUM Grauer. In *Pinus banksiana* burns, *Salix—Calamagrostis* vegetation on a creek margin and on a granite cliff. H. L. *946-62, 1002-62, 303-63;* P. L. *451-63.*

R. HUDSONIANUM Richards. In *Picea mariana* woods on eskers and in wet muskegs. H. L. *943-62, 242-63;* P. L. *486-63.*

R. LACUSTRE (Pers.) Poir. In *Picea mariana —Salix planifolia* woods. H. L. *312-63.* Specimen vegetative.

R. OXYACANTHOIDES *L.* In burned *Picea mariana*—lichen woods on bedrock outcrop. H. L. *210-63.* Speciment vegetative.

R. TRISTE Pall. In *Picea mariana—Salix planifolia* woods and on a granite cliff. H. L. *308-63;* P. L. *458-63.*

SAXIFRAGA TRICUSPIDATA Rottb. In dry habitats including lichen-covered depressions on eskers, *Picea mariana*—lichen woods and as a pioneer species on sandy-gravel ridges. H. L. *829-62, 100-63, 205-63.*

ROSACEAE

POTENTILLA FRUITICOSA *L.* On lake margins, in *Picea mariana* muskegs and in a *Betula glandulosa—Vaccinium uliginosum* thicket on the moist boulder field where it is a co-dominant. H. L. *200-63, 344-63.*

P. NIVEA L. Seen only on a metamorphic cliff. H. L. *230-63.*

The second report of this arctic—circumpolar species reported previously from Lake Athabasca (Raup, 1936).

P. NORVEGICA L. Rare, in mossy drainage area in a *Picea mariana* woods, and on a bank beaver house. H. L. *913-62;* P. L. *408-63.*

P. PALUSTRIS (L.) Scop. Occurs in wet muskegs and in very wet *Carex* fens. H. L. *240-63, 252-63.*

P. TRIDENTATA Ait. A pioneer species in sandy blowouts on eskers and on mineral soil in burns. H. L. *832-62, 1011-62, 163-63.*

RUBUS ACAULIS Michx. Frequent in moist *Picea mariana* woods, mixed *P. glauca—P. mariana—Larix laricina* woods, *Salix* thickets and in the tundra on the moist boulder field. H. L. *974-62, 1023-62, 167-63;* P. L. *409-63.*

R. CHAMAEMORUS L. On *Sphagnum* in *Picea mariana* muskegs and in wet mossy streamside woods. H. L. *896-62, 241-63.*

R. IDAEUS L. var. STRIGOSUS (Michx.) Maxim. In mossy streamside woods, burned *Picea mariana*—lichen woods on dry outcrop ridges, and on granite cliffs. H. L. *894-62, 203-63, 306-63A;* P. L. *449-63.*

LEGUMINOSAE

ASTRAGALUS ALPINUS L. Rare, in *Picea mariana* muskegs and in the tundra on the moist boulder field. H. L. *223-63, 268-63, 321-63.*

A. AMERICANUS (Hook.) M. E. Jones. Rare, collected only in a *Picea mariana* burn. H. L. *224-63.*

A. EUCOSMUS Robins. Rare, collected only on a metamorphic cliff. H. L. *232-63.*

EMPETRACEAE

EMPETRUM HERMAPHRODITUM (Lge.) Hagerup (*E. nigrum* L.). A pioneer on sandy blowouts and dry, lichen covered depressions on eskers; common in *Picea mariana*—lichen woods and abundant in the tundra on the dry rock field. H. L. *966-62, 1012-62, 288-63;* P. L. *369-63.*

VIOLACEAE

VIOLA PALUSTRIS L. In streamside woods and in the tundra on the moist boulder field where it is growing in sand between boulders. H. L. *902-62, 1021-62, 34-63, 337-63, 474-63.*

ELAEAGNACEAE

SHEPHERDIA CANADENSIS (L.) Nutt. Seen only once in a burned *Picea mariana* woods on a granite outcrop ridge. H. L. *206-63.*

ONAGRACEAE

EPILOBIUM ANGUSTIFOLIUM L. Common in burns and in upland *Picea mariana* woods. H. L. *1040-62, 158-63.*

E. PALUSTRE L. In *Sphagnum* in wet muskegs, in the tundra on the moist boulder field and on a bank beaver house. H. L. *914-62, 1018-62, 255-63, 338-63.*

HALORAGIDACEAE

HIPPURIS VULGARIS L. Aquatic on lake margins. H. L. *889-62.*

MYRIOPHYLLUM SPICATUM L. ssp. EXALBESCENS (Fern.) Hult. Aquatic in fast-flowing streams. H. L. *886-62.*

UMBELLIFERAE

CICUTA MACKENZIEANA Raup. Frequent in wet *Carex* fens and in *Sphagnum* in wet muskegs. H. L. *912-62, 249-63.*

CORNACEAE

CORNUS CANADENSIS L. In *Picea mariana* muskegs and on rocky lake shores. H. L. *1041-62.*

PYROLACEAE

PYROLA ASARIFOLIA Michx. In *Picea mariana* muskegs and on sandy esker slopes. H. L. *215-63, 318-63.*

P. GRANDIFLORA Radius var. CANADENSIS (Andres) Porsild. In a *Picea mariana—Betula "papyrifera"* woods along a stream. H. L. *899-62.*

This variety, new to the flora of Saskatchewan, was previously reported from Nueltin Lake, N.W.T., by Baldwin (1953). The species is uncommon in northern Saskatchewan.

P. MINOR L. In *Salix* thickets on stream margins and in *Salix—Carex* fens. H. L. *355-63;* P. L. *475-63.*

P. SECUNDA L. Infrequent, in *Picea mariana* muskegs where it usually occurs on *Sphagnum* hummocks. H. L. *872-62; P. L. 359-63, 391-63.*

ERICACEAE

ANDROMEDA POLIFOLIA L. In wet *Sphagnum* depressions in *Picea mariana* muskegs and in *Betula glandulosa—Vaccinium uliginosum* thickets. H. L. *841-62, 279-63.*

ARCTOSTAPHYLOS ALPINA (L.) Spreng. ssp. RUBRA (Rehd. & Wils.) Hult. Common in *Picea mariana* muskegs and in *P. glauca—P.*

mariana—Larix laricina woods. H. L. *1038-62. 171-63, 277-63.*

A. UVA-URSI (L.) Spreng. var. COACTILIS Fern. & Macbr. In dry *Picea mariana*—lichen woods and in lichen-covered depressions on eskers. H. L. *238-63.*

CHAMAEDAPHNE CALYCULATA (L.) Moench. Locally abundant in *Sphagnum* bogs and on the margins of *Carex* fens. H. L. *1049-62;* P. L. *473-63.*

KALMIA POLIFOLIA Wang. Scattered in *Picea mariana* muskegs and in *Scirpus—Vaccinium uliginosum* fens. H. L. *869-62, 159-63, 187-63, 296-63.*

LEDUM GROENLANDICUM Oeder. Frequent, in *Picea mariana*—lichen woods and P. *mariana* muskegs. H. L. *909-62, 126-63.*

L. PALUSTRE L. var. DECUMBENS Ait. In *Picea mariana*—lichen woods, *P. mariana* muskegs and in the tundra on the dry rock field. H. L. *910-62, 130-63;* P. L. *380-63.*

LOISEULERIA PROCUMBENS (L.) Desv. Frequent in *Picea mariana*—lichen and feather moss woods on eskers and abundant in the tundra on the dry rock field. H. L. *821-62, 195-63;* P. L. *375-63.*

This is the second report of this arctic—circumpolar for Saskatchewan, previously reported from Little Faroud Lake (Scotter, 1961). This species apparently becomes more important to the eastward for Ritchie (1959) reports that it dominates the summits of drift hills in the vicinity of Seal River, Manitoba, and Scotter (1965) has collected it at Kasmere Lake, Manitoba.

OXYCOCCUS MICROCARPUS Turcz. Trailing on *Sphagnum* in *Picea mariana* muskegs. H. L. *101-63, 119-63.*

VACCINIUM MYRTILLOIDES Michx. Found only in dry *Picea mariana*—lichen woods and in *Pinus banksiana* woods on sandy soil. H. L. *969-62, 307-63.*

V. ULIGINOSUM L. Frequent in *Picea mariana*—lichen woods and *P. mariana* muskegs, co-dominant in *Betula glandulosa* thickets on the moist boulder field, common on lake margins, granite cliffs and in *Carex* fens. H. L. *967-62, 343-63.*

V. VITIS-IDAEA L. var. MINUS Lodd. Frequent in *Picea mariana*—lichen and feather moss woods, and muskegs and occurs on dry lichen slopes on eskers. H. L. *127-63.*

PRIMULACEAE

PRIMULA MISTASSINICA Michx. Rare, occurring as individuals in mosses on rocky lake shores. H. L. *1043-62;* P. L. *398-63.* The latter collection may be referred to forma *leucantha* Fern.

GENTIANACEAE

GENTIANELLA AMARELLA (L.) Börner ssp. ACUTA (Michx.) J. M. Gillett. Occasional on dry slopes in *Picea mariana* burns. H. L. *936-62, 999-62, 212-63.*

MENYANTHES TRIFOLIATA L. On stream margins and in very wet *Carex* fens. H. L. *874-62, 133-63.*

HYDROPHYLLACEAE

PHACELIA FRANKLINII (R. Br.) Gray. In burned *Picea mariana*—lichen woods on dry slopes. H. L. *146-63, 204-63.*

LABIATAE

SCUTELLARIA GALERICULATA L. var. EPILOBIIFOLIA (Hamilt.) Jordal. Seen only under a dense thicket of *Salix serissima, S. planifolia* and *Betula glandulosa* on the moist boulder field. H. L. *333-63.*

SCROPHULARIACEAE

PEDICULARIS LABRADORICA Wirsing. Occasional in *Picea mariana*—lichen woods on eskers, pond margins in *Vaccinium uliginosum—Scirpus* fens, and frequent in the tundra on the dry rock field. H. L. *816-62, 107-63, 129-63, 185-63;* P. L. *376-63.*

This is the second report of this species for Saskatchewan; previously known from McKeever L. (Scotter, 1961).

VERONICA SCUTELLATA L. Seen only in a *Salix—Calamagrostis* fen on a lake margin. H. L. *972-62.*

LENTIBULARIACEAE

PINGUICULA VULGARIS L. Locally abundant in a *Vaccinium uliginosum—Scirpus* fen on a pond margin but not seen elsewhere. H. L. *183-63.*

This record is a northward extension of the Saskatchewan range of this arctic (subarctic)—circumpolar species. It was previously known from isolated southern populations at Prince Albert where it occurs in a *Carex* fen (calcareous bog) and at Strawberry Lakes, a remarkable record well within the prairie 42 miles east of Regina, Saskatchewan (Jones, 1964).

UTRICULARIA INTERMEDIA Hayne. Frequent as an aquatic in sluggish streams and in pools

in *Picea mariana* muskegs and *Sphagnum* bogs. H. L. *888-62, 1052-62;* P. L. *483-63.*

U. VULGARIS L. var. AMERICANA Gray. Frequent in sluggish streams and very wet *Carex* fens. H. L. *890-62, 923-62, 132-63.*

RUBIACEAE

GALIUM TRIFIDUM L. Of scattered occurrence, trailing in wet mosses on lake margins, in *Carex* fens and in the tundra on the moist boulder field. H. L. *917-62, 1022-62, 165-63, 324-63.*

CAPRIFOLIACEAE

LINNAEA BOREALIS L. ssp. AMERICANUM (Forbes) Hult. Infrequent in mixed woods on stream margins and in *Picea mariana—Pinus banksiana* burn regeneration. H. L. *897-62, 103-63.*

VIBURNUM EDULE (Michx.) Raf. Uncommon in *Picea mariana* muskegs and in burned *P. mariana*—lichen woods. H. L. *868-62, 208-63.*

SANTALACEAE

GEOCAULON LIVIDUM (Richards.) Fern. In *Picea mariana*—lichen woods on esker. H. L. *968-62, 128-63.*

COMPOSITAE

ANTENNARIA NEGLECTA Greene. On dry slopes in *Picea mariana* burn regeneration. H. L. *933-62.*

A. PULCHERRIMA (Hook.) Greene. In a *Picea mariana* burn on a boulder field. H. L. *222-63.*

A. ROSEA (D. C. Eat.) Greene. On a dry slope in *Picea mariana* burn regeneration. H. L. *934-63.*

A. UMBRINELLA Rydb. (*A. isolepis* Greene). In a lichen covered depression on an esker. H. L. *828-62.*

ARNICA LONCHOPHYLLA Greene. On mineral soil in *Picea mariana* burns, and in *P. mariana* —lichen woods. H. L. *817-62, 998-62, 162-63.*

ARTEMISIA CAMPESTRIS L. ssp. BOREALIS (Pall.) Hall & Clements. A pioneer species in sand blowouts and open sandy-gravel slopes on eskers. H. L. *834-62, 317-63;* W. L. *599-63, 605-63.*

ERIGERON ACRIS L. var. ASTEROIDES (Andrez) Bess. On dry esker slopes, lichen-covered depressions and in *Picea mariana* burns. H. L. *825-62, 148-63, 196-63.*

E. HYSSOPIFOLIUS Michx. In *Sphagnum* in *Picea mariana* muskegs and in *P. glauca—P. mariana—Larix laricina woods.* H. L. *941-62, 168-63.*

Apparently only the second collection of this species for Saskatchewan; previously collected by J. Hudson at Amisk Lake (Breitung, 1957).

E. LONCHOPHYLLUS Hook. In *Picea mariana* muskegs and in *Salix—Betula glandulosa* thickets on lake margins. H. L. *856-62, 314-63;* P. L. *399-63.*

PETASITES FRIGIDUS (L.) Fries var. PALMATUS (Ait.) Cronq. Common in *Picea mariana* muskegs and in moist, mossy woods along streams. H. L. *942-62, 214-63, 310-63, 313-63.*

P. SAGITTATUS (Pursh) Gray. Seen only once in a *Picea mariana* muskeg. H. L. *878-62.*

SENECIO PAUPERCULUS Michx. Common in *Picea mariana* muskegs and on moist slopes. H. L. *866-62. 1016-62, 154-63, 201-63.*

SOLIDAGO SPATHULATA DC. ssp. SPATHULATA var. NEOMEXICANA (Gray) Cronq. Frequent on eskers in *Picea mariana*—lichen woods, dry lichen-covered slopes, and in an *Agrostis scabra* meadow. H. L. *818-62, 830-62, 930-62;* W. L. *604-63.*

A specimen (H. L. *164-63*) collected on a till ridge growing in mineral soil is very similar to the above specimens but may represent ssp. *randii* var. *racemosa* (Greene) Cronq. (Cronquist, personal communication).

TARAXACUM CERATOPHORUM (Ledeb.) DC. Rare in *Picea mariana* muskegs, wet mossy woods along streams and on a metamorphic cliff. H. L. *1015-62, 315-63, 228-63.*

This is the second report of this species for Saskatchewan; previously reported from Lake Athabasca (Raup, 1936).

Bryophyta

HEPATICAE

LOPHOZIA WENZELII (Nees) Steph. In *Picea mariana* muskegs and *Salix—Calamagrostis* thickets. H. L. *980-62, 987-62.*

New to the flora of Saskatchewan.

PTILIDIUM CILIARE (L.) Nees. In *Picea mariana*—lichen woods on eskers and in mixed woods on stream margins. H. L. *903-62, 959-62, 960-62.*

Musci

SPHAGNALES

SPHAGNUM CAPILLACEUM (Weiss) Schrank. Muskegs. H. L. *986-62.*

S. CAPILLACEUM var. TENELLUM (Schimp.) Andr. Muskegs. H. L. *911-62, 992-62.*

S. CUSPIDATUM Ehrh. In standing water in muskeg. H. L. *266-63.*

New to the flora of Saskatchewan; known also from Manitoba (Ritchie, 1959).

S. FUSCUM (Schimp.) Klinggr. Muskegs and *Sphagnum* bogs. H. L. *1053-62, 275-63, 278-63.*

S. GIRGENSOHNII Russ. Muskegs. H. L. *984-62.*

S. LINDBERGII Schimp. Muskegs. H. L. *302-63B.*

New to the flora of Saskatchewan; known also from Manitoba (Ritchie, 1959).

S. RECURVUM P. Beauv. var. PARVIFOLIUM Sendt. ex Warnst. *Sphagnum* bogs. H. L. *1056-62, 1057-62.*

This is the first report of this variety from Saskatchewan; the species was previously reported by Macoun (1892).

S. SQUARROSUM Crom. In *Picea mariana—Betula "papyrifera"* woods along a stream. Associated with *Drepanocladus uncinatus* and *Hylocomium splendens*. H. L. *905-62.*

S. WARNSTORFIANUM Du Rietz. Muskegs. H. L. *279-63, 281-63.*

S. WULFIANUM Girg. Muskegs H. L. *267-63.*

This is the second Saskatchewan record of this species previously reported by Macoun (1892).

EUBRYA

AULACOMNIUM PALUSTRE (Hedw.) Schwaegr. In muskegs, bogs, and wet drainage areas in *Picea mariana* woods. H. L. *982-62, 1055-62;* P. L. *411-63B, 415-63.*

BRYUM PSEUDOTRIQUETRUM (Hedw.) Schwaegr. Muskegs. H. L. *274-63.*

CALLIERGON GIGANTEUM (Schimp.) Kindb. Aquatic moss in lake. H. L. *102-63.*

New to the flora of Saskatchewan.

CINCLIDIUM STYGIUM Sw. Wet drainage area in *Picea mariana* woods. P. L. *412-63.*

CYNODONTIUM STRUMIFERUM (Hedw.) Lindb. On a lichen—covered boulder. H. L. *961-62.*

C. TENELLUM (BSG) Limpr. On dripping wet granite cliff. P. L. *465-63, 467-63A.*

New to the flora of Saskatchewan.

DICRANUM ANGUSTUM Lindb. Muskegs. H. L. *273-63.*

New to the flora of Saskatchewan.

D. BERGERI Bland. Muskegs. H. L. *271-63.*

D. ELONGATUM Schleich. In mossy streamside woods and on dripping wet granite cliffs. H. L. *906-62, 907-62;* P. L. *466-63.*

DREPANOCLADUS EXANNULATUS (BSG) Warnst. *Sphagnum* Bog. H. L. *1054-62.*

New to the flora of Saskatchewan.

D. REVOLVENS (Turn.) Warnst. var. INTERMEDIUS (Lindb.) Richs. & Wall. Muskeg H. L. *302-63A.*

New to the flora of Saskatchewan.

D. UNCINATUS (Hedw.) Warnst. Muskegs. H. L. *274-63.*

D. VERNICOSUS (Lindb.) Warnst. Wet drainage area in *Picea mariana* woods. P. L. *413-63, 416-63.*

New to the flora of Saskatchewan.

HYLOCOMIUM SPLENDENS (Hedw.) BSG. In muskegs, *Picea mariana*—feathermoss woods and in mixed woods along streams. H. L. *908-62, 983-62D, 988-62, 265-63;* P. L. *411-63.*

HYPNUM CUPRESSIFORME Hedw. On a rock outcrop in a muskeg. H. L. *1059-62.*

MEESIA ULIGINOSA Hedw. Muskegs. H. L. *272-63, 274-63.*

New to the flora of Saskatchewan.

MNIUM ANDREWSIANUM Steere. Muskegs. H. L. *274-63.*

PALUDELLA SQUARROSA (Hedw.) Brid. Muskegs. H. L. *270-63.*

PLEUROZIUM SCHREBERI (Brid.) Mitt. *Picea mariana*—lichen woods, muskegs, and mixed woods on stream margins. H. L. *904-62 959-62, 993-62, 300-63.*

POHLIA CRUDA (Hedw.) Lindb. On rock outcrop in muskeg. H. L. *272-63.*

P. NUTANS (Hedw.) Lindb. In mixed woods on stream margin. H. L. *906-62.*

POLYTRICHUM COMMUNE Hedw. Muskegs. H. L. *990-62A.*

P. JUNIPERINUM Hedw. In a *Picea mariana* burn on esker. H. L. *1001-62.*

P. PILIFERUM Hedw. In *Picea mariana*—lichen woods. H. L. *290-63.*

PTILIUM CRISTA-CASTRENSIS (Hedw.) De-Not. In muskegs and *Picea mariana*—feather moss woods. H. L. *990-62B, 991-62, 264-63.*

RHACOMITRIUM CANESCENS (Hedw.) Brid. On a lichen—covered boulder in *Picea mariana*—lichen woods. H. L. 962-62.

New to the flora of Saskatchewan.

R. CANESCENS f. ERICOIDES (Brid.) Mönk. On open sandy-gravel on esker. W. L. *597-63.*

New to the flora of Saskatchewan.

SPLACHNUM LUTEUM Hedw. In *Picea mariana* woods. P. L. *421-63.*

New to the flora of Saskatchewan.

TAYLORIA LINGULATA (Dicks.) Lindb. Muskegs. H. L. *274-63.*

TETRAPLODON MNIOIDES (Hedw.) BSG. In muskeg, on bone chips and other animal remains in substrate. H. L. *924-62, 989-62.*

TOMENTHYPNUM NITENS (Hedw.) Loeske. Muskegs. H. L. *280-63*.

ULOTA CRISPA (Hedw.) Brid. On dripping wet granite cliffs. P. L. *465-63A*, *467-63B*.

New to the flora of Saskatchewan.

Lichens

ACTINOGYRA MUHLENBERGII (Ach.) Schol. On a granite cliff. P. L. *461-63*.

ALECTORIA NADVORNIKIANA Gyel. On dead branches of *Picea mariana*. H. L. *953-62*.

CETRARIA NIVALIS (L.) Ach. In *Picea mariana*—lichen woods on esker. H. L. *952-62*.

CLADONIA ALPESTRIS (L.) Rabh. On a granite cliff. P. L. *454-63*.

C. ALPICOLA (Flot.) Vainio. On a granite cliff. P. L. *455-63*.

C. AMAUROCREA (Flk.) Schaer. In muskegs and on a granite cliff. H. L. *985-62*, *299-63*; P. L. *453-63*.

C. CORNUTA (L.) Schaer. On granite cliffs. P. L. *459-63*.

C. DEFORMIS (L.) Hoffm. In a muskeg. H. L. *983-62C*.

C. MITIS Sandst. In upland *Picea mariana*—lichen woods and in muskegs. H. L. *951-62*; *983-62A*, *291-63*.

C. PLEUROTA (Flk.) Schaer. In *Picea mariana*—lichen woods on esker. H. L. *964-62*.

C. RANGIFERINA (L.) Web. In *Picea mariana* muskegs, feathermoss woods and on a granite cliff. H. L. *983-62B*, *262-63*, *301-63*; P. L. *460-63*.

C. UNCIALIS (L.) Web. In *Picea mariana*—lichen woods on a granitic outcrop. Mixed with *C. amaurocraea*, *C. alpestris* and *C. mitis*. H. L. *293-63*.

ICMADOPHILA ERICETORUM (L.) Zahlbr. On mineral soil in *Picea mariana*—lichen woods on an esker. H. L. *955-62*.

LECANORA DISPERSA (Pers.) Rohl. On a boulder in a *Picea mariana*—lichen woods. H. L. *965-62A*.

New to the flora of Saskatchewan.

L. POLYTROPA (Ehrh.) Rabenk. On a boulder in a *Picea mariana*—lichen woods. H. L. *965-62A*.

LECIDEA LAPICIDA Ach. On rock outcrop in muskeg. H. L. *1060-62*.

NEPHROMA ARCTICUM (L.) Torss. In *Picea mariana*—lichen woods. H. L. *958-62*, *261-63*.

PARMELIA PHYSODES (L.) Ach. On dead branches of *Picea mariana*. H. L. *954-62*.

PELTIGERA APHTHOSA (L.) Willd. In a *Picea mariana* muskeg. H. L. *944-62*.

P. MALACEA (Ach.) Funck. On a granite cliff. P. L. *452-63*.

RHIZOCARPON DISPORUM (Naeg.) Müll. Arg. On a boulder in a *Picea mariana*—lichen woods. H. L. *965-62*.

R. GEOGRAPHICUM (L.) DC. On a boulder in *Picea mariana*—lichen woods on an esker. H. L. *965-62A*.

STEREOCAULON PASCHALE (L.) Hoffm. Common in *Picea mariana*—lichen woods on eskers. H. L. *950-62*, *289-63*, *292-63*.

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EXTRALIMITAL OCCURRENCES OF RACCOONS IN ONTARIO

DONALD W. SIMKIN
Ontario Department of Lands and Forests, Southern Research Station, Maple, Ontario

THE RACCOON, *Procyon lotor*, is a common mammal in southern and central Ontario but becomes rare as one proceeds north and west in the province. Anderson (1946) stated that casual records were made at Parry Sound, Nipigon and Attawapiskat Lake. Downing (1948) described the northwestern distribution and status of this species are rare in the Rainy River District with occasional individuals wandering farther north, and he mentions a report of the species from Lake Nipigon. Elsey (1950) reported a raccoon which was caught in the fall of 1946 north of Long Lac. Hall and Kelson (1959 : 885) show no record of raccoons in northwestern Ontario.

Sutton (1964) has reported a recent northward extension of the range of this species in adjacent Manitoba. In that province individuals have been taken from as far north as 55°N latitude.

The author was employed from 1957-61 as District Biologist by the Ontario Department of Lands and Forests in the Sioux Lookout Forest District. This District encompasses the northwestern 140,000 square miles of the province. While stationed there, two raccoon specimens were received from

TABLE 1.—Extralimital Occurrences of Raccoons in Northwestern Ontario, 1927 to 1960

Record Number	Date	Location	Latitude	Longitude	How Killed
1	1927	Cordingly Lake	50° 15′N	86° 40′W	Trapped
2	1935	Berry Lake	52° 35′N	91° 10′W	Trapped
3	1937–42	Sasaginiga Lake	52° 21′N	91° 01′W	Trapped
4	1942	Goldpines	50° 40′N	93° 10′W	Trapped
5	1946–47	Pickle Lake Area	51° 30′N	90° 13′W	Trapped
6	1948–49	Birch Lake	51° 25′N	92° 20′W	Trapped
7	1949–50	Sandy Lake	53°N	93°W	Trapped
8	June, 1949–52	Caribou Lake	50° 30′N	89°W	Trapped
9	November, 1952	Windigo Lake	52° 35′N	91° 30′W	Dogs
10	November, 1952	Cemetery Lake	52° 53′N	90° 50′W	Trapped
11	1952–53	Schist Lake	50° 10′N	91° 30′W	Trapped
12	1953	Uchi	51°N	92° 30′W	Trapped
13	November, 1956	Big Trout Lake	53° 45′N	90°W	Trapped
14*	November, 1957	Junction Severn & Rocksand Rivers	55° 09′N	88° 28′W	Trapped
15*	January, 1960	Collins	50° 15′N	89° 28′W	Found dead

*Specimens located in the collection of the Royal Ontario Museum.
14 — accession No. 28104,
15 — accession No. 31298.

FIGURE 1. Map of northern Ontario showing locations of raccoons reported in Table 1.

Indian trappers. A search of the District files and a series of interviews with trappers throughout the District resulted in an additional 13 records. Most of these came from old records in the files and were a result of trappers catching an animal strange to them and either sending it to Sioux Lookout or presenting the pelt to officials for identification at one of the annual trappers' meetings.

This paper includes 15 records of raccoons from areas which are north or northwest of any included in the literature relating to the species' distribution in Ontario. They are listed in Table 1 and plotted in Figure 1. Some of the dates are not for a specific year, (reports number 3, 5, 6, 7, 8 and 11) since

when questioned, the trapper could not remember the exact year that he caught the animal.

It does not appear that there has been a large scale invasion of raccoons to the north during any one year, rather, there have been sporadic occurrences of single individuals over a long period of time. There is also no evidence available to indicate that there is an established population anywhere in northwestern Ontario at the present time except in the Rainy River region.

Likely any animals, which manage to get so far north of their normal range, perish during the unusually severe winters characteristic of the area here discussed. Evidence to indicate that such is the case is that four of the six animals, for which we know the month in which they were trapped, were killed in November and another was found dead in January. The fact that these animals were caught in traps at this time of year, when ordinarily they would be denned-up and inactive, indicates that they were probably not well enough prepared for winters as severe as they encountered. Another limiting factor for pioneering raccoons in northwestern Ontario must be the scarcity of large, hollow deciduous trees so often used as dens in their normal range.

The increasing number of occurrences of raccoons in northwestern Ontario in the last twenty years may be the result of a warming trend in the climate. However, it does not appear that climatic conditions are yet suitable for a population to become established.

The Fish and Wildlife Branch staff of the Ontario Department of Lands and Forests at Sioux Lookout was responsible for the pre-1957 collection of records and assisted in the collections of additional records at the trappers' meetings.

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OBSERVATIONS ON CANADIAN BIRCH (BETULA) COLLECTIONS AT THE MORGAN ARBORETUM III. *B. PAPYRIFERA* OF BRITISH COLUMBIA

W. H. Brittain and W. F. Grant[1]
The Morgan Arboretum, Macdonald College, P.Q.

The observations recorded in this paper are based on specimens collected in British Columbia in the autumn of 1962, as part of a survey undertaken to secure seed of *Betula papyrifera* Marsh., for the purpose of establishing in the Morgan Arboretum at Macdonald College a representative living collection of this species. This objective has been achieved and the seedling progeny of all specimens collected will now serve, not only as a basis for a study of intraspecific variation within this species, but also as a reservoir for controlled hybridization studies.

The belief that the two bark colors composing the white birch complex in British Columbia, a larger tree called the "Western White Birch" and a much smaller one called the "Northwestern White Birch", represent two distinct varieties has been generally accepted (Sargent, 1922; Rehder, 1940). The first of these is recognized by its smooth, close, dark brown bark, and such individuals are included under the varietal name *B. papyrifera* var. *commutata* (Regel) Fern. However, Fernald (1945), who proposed the foregoing combination, rightly points out that, "In the East trees, otherwise inseparable from *B. papyrifera*, may have the bark permanently quite as dark as in the trees of Puget Sound and the lower Fraser River", but later (1950) the same author uses this character only to separate *B. papyrifera* var. *commutata* from *B. papyrifera* typica. Trees belonging to the second color form, characterized by light colored bark, either white, grey or silvery and often tinged with purple, pink or bronzy coloration, have been classified as *B. papyrifera* var. *subcordata* (Rydb.) Sarg. The range of the latter has been given as "Alberta and British Columbia, and from eastern Washington and northeastern Oregon (Wallowa Mountains) east to northern Idaho and western Montana" (Little, 1953).

The majority of our collections are from the Lower Fraser Valley and from the West and South Central areas of British Columbia. In addition, we have included in our study two trees from the Arnold Arboretum, one labelled var. *commutata* (Acc. No. 90) and another labelled var. *subcordata* (Acc. No. 86). For further comparison, we have also included a specimen (Acc. No. 320) from the Haines Road in the Alaska Panhandle. In collecting from sites in which both color forms occurred, as was commonly the case in the Southern Coastal and West Central regions, a definite attempt was made to secure a collection from a comparable tree for each of the two color forms. The morphological and cytological techniques employed have been previously

[1]Scientific Advisor, The Morgan Arboretum, and Associate Professor, Department of Genetics, respectively.

described (Brittain and Grant, 1965). From observations made during the collection of this material, from a study of herbarium specimens from these collections and from the Gary Herbarium of Harvard University and the National Museum of Canada, Ottawa, together with studies of the seedlings grown from the collections, certain significant facts have emerged which form the subject of this paper.

OBSERVATIONS

Table 1 summarizes the more outstanding characters from the technical description prepared for each specimen. The fruiting and folial characters may be observed in the figures of selected specimens (Figures 1, 2 and 3), in which the numbers correspond to the accession numbers given in Table 1. In Table 1 the designation "white" bark is taken to include all trees with light colored bark, which include grey and silvery forms.

In considering these data, it should be borne in mind, as pointed out elsewhere (Brittain and Grant 1965), that the form of the fertile bracts and that of the basal leaf area are highly variable in *B. papyrifera sensu stricta* and have little or no varietal significance within the species. It will be noted, also, that the somatic chromosome numbers 56, 70 and 84, as determined from eastern material, are likewise characteristic of these British Columbia specimens.

One of the facts to emerge early in our study was that, apart from the normal variation to be expected in such a polymorphic species, no significant or constant character between the two color forms could be detected, other than the single character of bark color. From Table 1 it is readily apparent that individuals of either form might have a somatic chromosome complement of 56, 70 or 84. A comparison between two apparently authentic specimens of *B. papyrifera* var. *commutata*, namely, the Arnold Arboretum tree (Acc. No. 90) grown from seed obtained from Kaslo, British Columbia in 1906 and our tree, Acc. No. 124 from the Arboretum of the University of British Columbia, is of special interest. These two trees were nearly alike in every measurable character except for color and size. The Arnold Arboretum specimen has completely white bark, whereas the University of British Columbia tree is dark below, lightish above, as commonly occurs in coastal trees that have not attained their complete growth. The somatic chromosome number 70 is the same for both. It is to be assumed that the parent tree of the Arnold Arboretum specimen also had dark bark, since, otherwise the specimen would not have been labelled var. *commutata*. It would appear that the dark color simply failed to develop in the new environment. This would suggest that some environmental factor may be correlated with bark color.

Regarding "close bark" so frequently mentioned in descriptions of var. *commutata*, it may be noted that the degree of exfoliation is a highly variable character in *B. papyrifera*, and trees with light bark, showing little or no sign of exfoliation, have been observed on many sites throughout the range of the species. It may also be noted that our Acc. No. 86 from the Arnold Arboretum attributed to var. *subcordata*, not only agrees with our British Columbia material in all essentials, but our description of this specimen might equally well be applied to specimens collected in eastern Canada with little or no change.

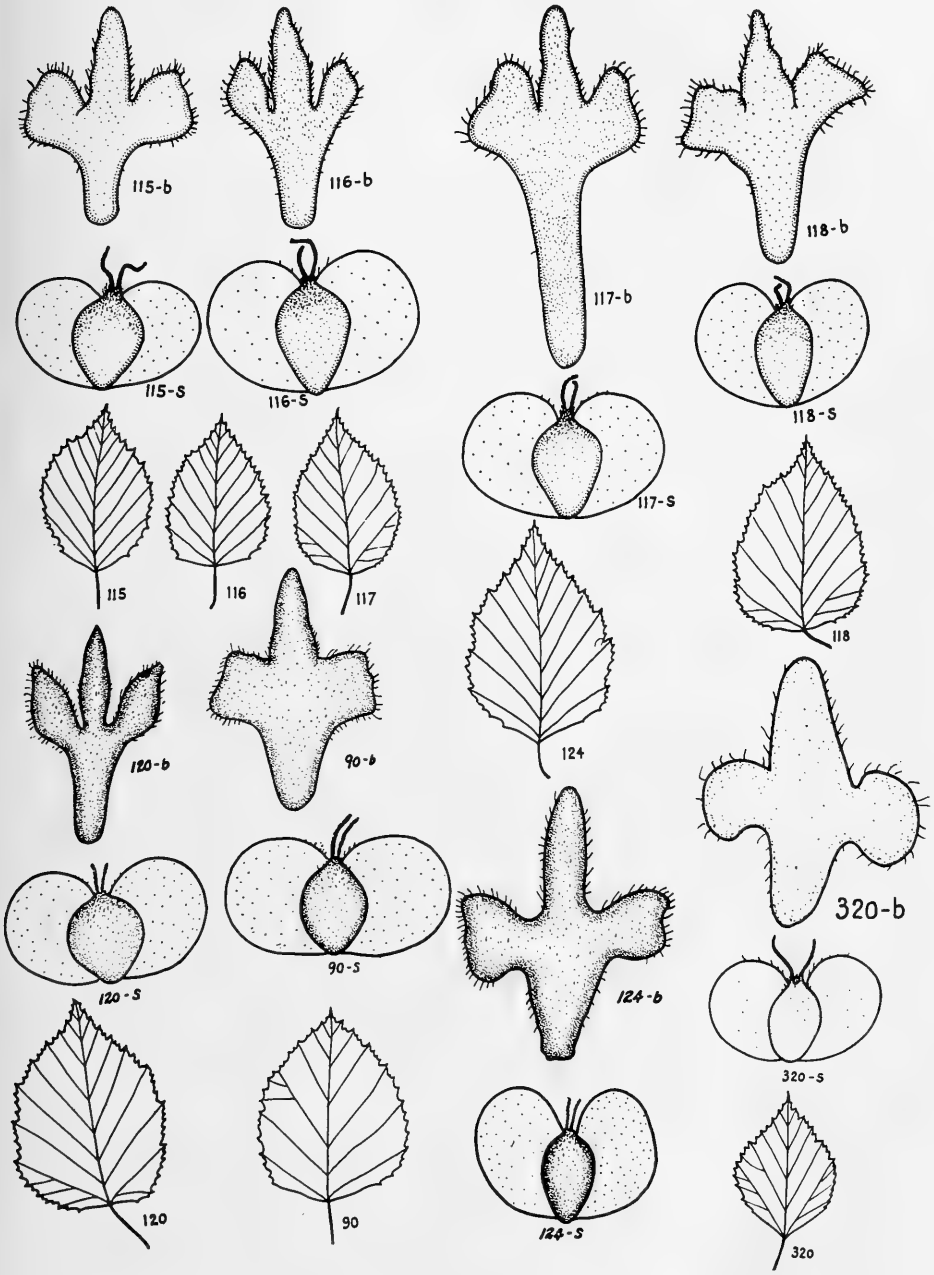

FIGURE 1. Representative illustrations of bracts and samaras (x ca. 6) and leaves (reduced ca. 3/5). The numbers refer to accession numbers as given in Table 1. b = bract; S = samara.

Although trees of this collection fitted the description for this variety as given by Sargent, the leaves were not subcordate. Likewise, the majority of the other specimens in our collections did not have subcordate leaves, though this character occurs as a folial variation in both eastern and western specimens.

One of our most interesting collections was made in a small isolated interior valley, situated 12 miles northwest of Summerland along the Fish Lake Road (Acc. Nos. 119, 120, 329). Here was found a stand of trees of similar age all with very dark brown bark which composed by far the most uniform population hitherto encountered. No other *Betula* species were observed in the near vicinity. The similarity between individuals extended to folial and fruiting characters (Figure 1, number 120). The smaller branchlets were decidely sticky, as were the buds, and the branchlets were also glandular. These characters occasionally occur in other forms, but were apparently universal in the members of this group. Moreover, seedlings from the three collections proved equally uniform in growth habits and in details of structure. Young seedlings were noticeably less densely pubescent than in most *B. papyrifera* seedlings, but glandular and sticky in all cases.

The trees growing on this site in the dry interior may be compared to those from a far different environment, namely Brier Island, Nova Scotia, a small windswept island projecting into the Bay of Fundy, where all the trees observed had very dark brown bark. Aside from their dwarfish size, due to unfavourable conditions for growth, the individuals of this group differed from those of the Fish Lake Road population in several respects. First, the chromosome number proved to be 70 or 84 and never 56. The branchlets of mature trees were pubescent, rarely glandular. The seedlings were densely pubescent as in most *B. papyrifera* in distinction to those from Fish Lake Road. The styles borne by the achenes on the Brier Island specimens were in all cases very short and stubby as compared with the latter and there were other minor but consistent differences, including the growth rate, which was markedly faster in the British Columbia trees, registering an average linear growth of 1.9 meters in four years of growth as compared with only 1.4 meters in five years for seedlings from Brier Island (Acc. No. 51). It appears, therefore, that the Fish Lake Road population exhibits, at least in some respects, certain consistent differences from both British Columbia specimens, and also those from other areas. It should be noted that plants of var. *commutata* are found near the coast in eastern Canada (Roland, 1945) in contrast to the British Columbia collections reported on here.

A very different situation was uncovered at a site on the Forest Experiment Station at Aleza Lake near Prince George, British Columbia. Here a group of trees closely resembling each other in general appearance differed widely in bark color. For example, Acc. Nos. 35-1, 35-4, 35-5 and 140 had very dark brown, close bark, whereas those of Acc. Nos. 35, 35-2 and 35-3 had white or greyish bark. The bracts of number 35 were characteristic of most of the trees in this area, being very long and narrow with reduced lateral lobes (Figure 3). On the other hand, the bracts in No. 140 had a very short peduncle with sharply recurved, well developed lobes, closely resembling those found in collections from other locations, namely, Acc. Nos. 130, 131 and 132. Chromo-

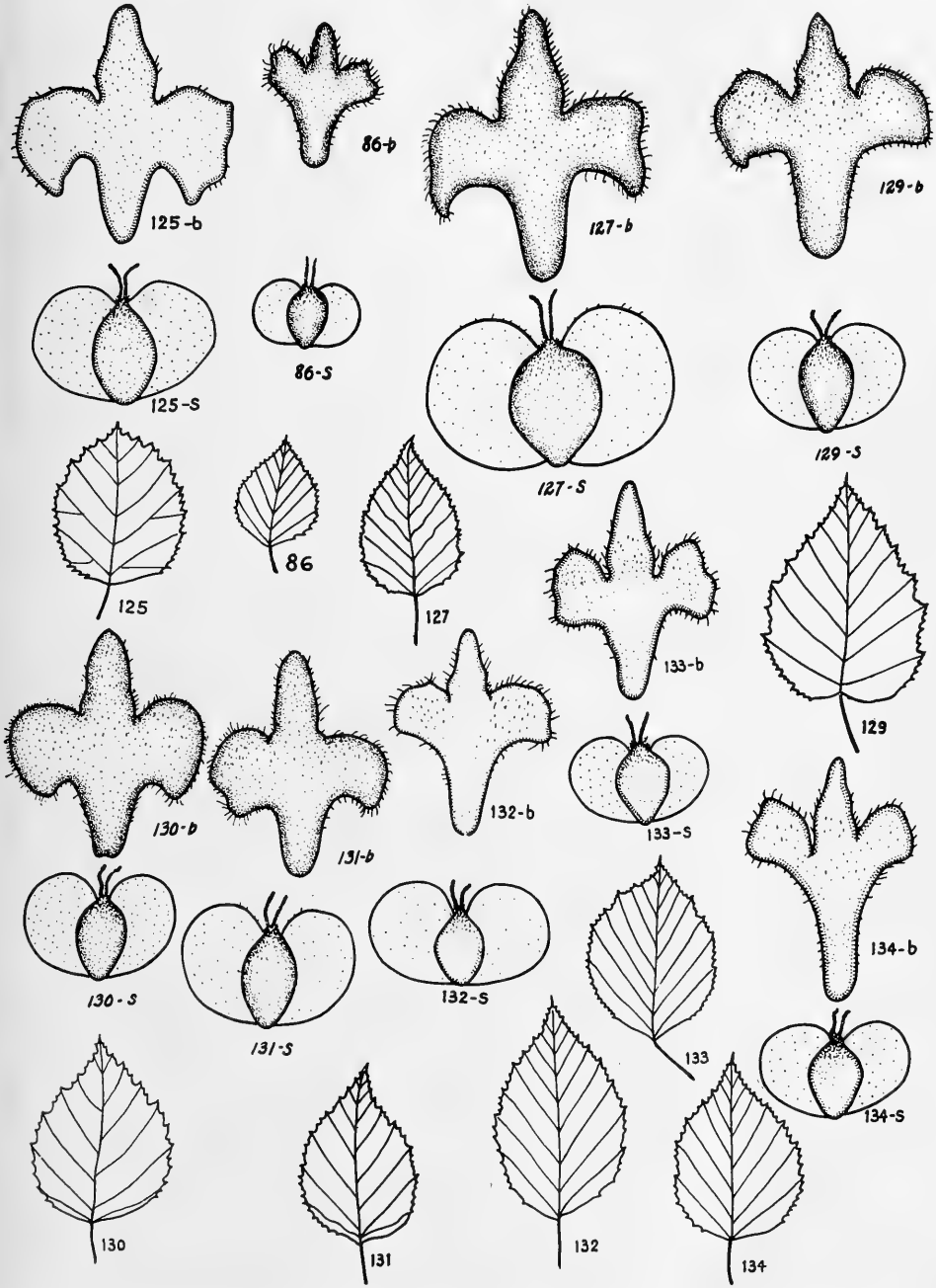

FIGURE 2. Representative illustrations of bracts and samaras (x ca. 6) and leaves (reduced ca. 3/5). The numbers refer to accession numbers as given in Table 1. b = bract; S = samara.

some number determinations from seedlings showed that the three chromosome numbers 56, 70 and 84 were present in this population (Table 1).

In comparing juvenile characters it was observed that, as elsewhere throughout the entire range of *B. papyrifera*, young seedlings, except as noted, were densely pubescent. This pubescence tends to disappear with age, but patches persist on the underside of the leaves, in the axils of the larger veins, and for a greater or lesser period on young shoots, particularly below the buds. Warty twigs are sometimes present on young seedlings, at least up to five years old, though this character is wanting or, if present, is less, or only slightly, developed in most mature specimens.

Data presented in Table 1 indicate that measurements of stomatal guard cells are of little value in distinguishing between plants possessing the higher chromosome numbers. While certain accessions could be selected to illustrate a trend of increasing size in guard cell with an increase in chromosome number, there is too great an overlap in stomatal measurements between these higher polyploid numbers and lower ones to be of value for classifying plants into tetraploids, pentaploids or hexaploids without resort to the determination of chromosome numbers.

DISCUSSION

It is relevant to point out that the collections which form the basis of this paper cover a wide geographical area and include several floral zones. They are comprised of individuals from varying age groups and, finally, they were necessarily confined to the accessible seed-bearing trees available in a poor seed year. Nevertheless, an examination of the data presented reveals a number of significant facts.

As noted in Table 1, somatic chromosome number determinations for seven accessions had a chromosome number of 56 (19 seedlings), 11 had 70, and 13 had 84. In addition, two seedlings of one accession had different somatic chromosome numbers, one with 56 and one with 70, although the seeds originated from a single parent tree, and likewise, in three accessions there were seedlings in a collection with 70 chromosomes and others with 84. No correlation could be determined between chromosome number and bark color and no consistent character could be detected to separate the two color forms. These particular collections, therefore, present no evidence to justify the retention of the varietal names *commutata* and *subcordata* as applied to British Columbia specimens. It is clear, therefore, that bark color alone is not necessarily a proof of varietal identity. This was emphasized by the case of the tree labelled var. *commutata* in the Arnold Arboretum, which presumably originated from a parent tree with "warm, dark brown bark", but which, growing in its present site, has white bark. However, we have already discussed the significance of bark color (Brittain and Grant, 1965) in birches and Dugle (1964) who has recently completed a most detailed and authoritative study of the genus *Betula* in Western Canada, also concludes that "there is no recognizable distinction between white-barked and dark-barked *Betula papyrifera*, and these are considered color forms".

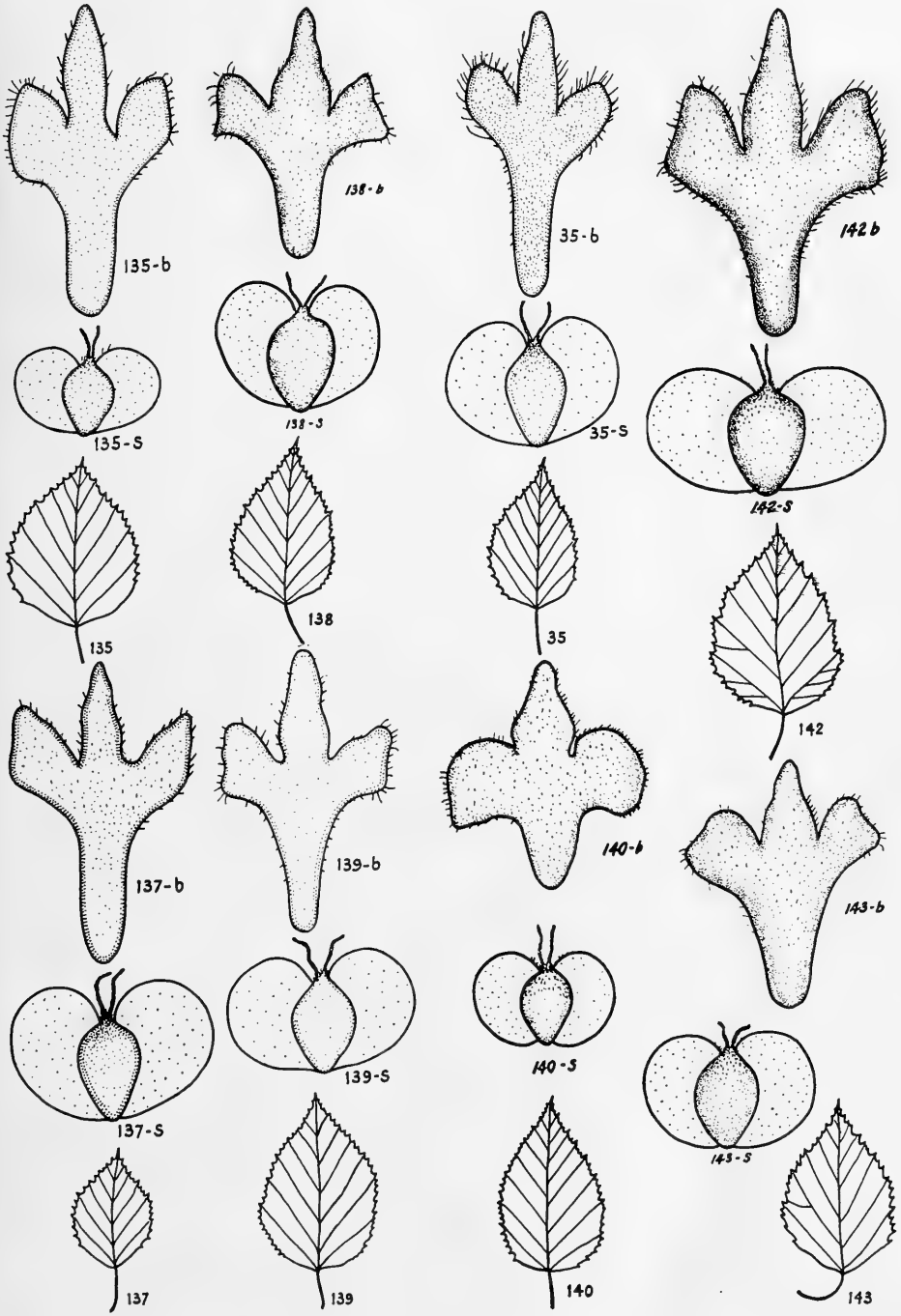

FIGURE 3. Representative illustrations of bracts and samaras (x ca. 6) and leaves (reduced ca. 3/5). The numbers refer to accession numbers as given in Table 1. b = bract; S = samara.

TABLE 1. — Observations on British Columbia collections

Acc. no.	Locality	Tree size		Somatic chromosome no.	Stomatal size (μ)	Bark	Remarks
		Diameter at breast height (cms)	Height (m)				
35	Aleza Lake	12.70	14.34	70	45.84	White, exfoliating	Young seedlings and branchlets of older trees slightly glandular, pubescent
35–1	Aleza Lake	12.70	14.34	70[1]		Brown	Similar to No. 35
35–2	Aleza Lake	12.70	14.34	84[1]		Brown	Similar to No. 35
35–3	Aleza Lake	12.70	14.34	56:70[6]		White	Similar to No. 35
35–4	Aleza Lake	12.70	14.34	56		White	Similar to No. 35
35–5	Aleza Lake	12.70	14.34	56		Brown	Similar to No. 35
140	Aleza Lake	12.70	24.40	70:84[5]	32.63	Dark brown, close	Differs in form of fertile bract
115	Armstrong	12.70	11.90	84		White, creamy	Styles 0.45 mm long, female ament plump with pubescent peduncle.
116	Salmon Arm	11.43	10.68	70		Dull, white, bronzy	Similar to No. 115
117	Trinity Valley	12.19	11.90	84		White	Similar to No. 115
118	Trinity Valley	7.62	9.15	70	39.56	Dark brown, no white showing	Similar to No. 115
119	Fish Lake Road	45.72	18.30	56[3]		Dark brown	Very characteristic bracts, branchlets glandular, sticky; buds sticky.
120	Fish Lake Road	76.20	26.84	56[2]	31.59	Dark brown	Similar to No. 119
329	Fish Lake Road			54[4]		Dark brown	Similar to No. 119
124	Vancouver	71.12	18.30	70	37.50	Lower part dark brown, upper light	Resembles No. 90 except for bark color.
125	Victoria	10.16		56	36.56	Brown, exfoliating to white	Branchlets finely and densely pubescent. Seedling growth much slower than No. 124.
126	Langley	7.62	8.54			Brownish	
127	Green Timbers	30.48	16.78	70	41.72	Dark brown	Branchlets pubescent
129	Green Timbers	35.56	15.25	84[1]	38.25	White	Resembles No. 127 except for bark color. Has some subcordate leaves
130	Abbotsford	40.64	14.64	84		White	Resembles No. 127
131	Abbotsford	33.02	22.88	70:84[5]		Very dark, close	Resembles No. 127 except for bark color

TABLE 1.—*Concluded*

Acc. no.	Locality	Tree size		Somatic chromosome no.	Stomatal size (μ)	Bark	Remarks
		Diameter at breast height (cms)	Height (m)				
132	Old Alexandra Bridge	17.02	11.29	70:84[7]	43.31	Dull grey to bronzy	
133	Hope	10.16	7.63	84		Dull grey to bronzy	
134	Williams Lake	19.05	14.34	84		White	
135	Alexandra	29.21	13.73	84		White	
136	Quesnel	19.30	14.34	84	45.47	White	Resembles No. 86
137	Quesnel	27.43	15.86	70	39.94	White	Resembles Nos. 119 and 120 except for bark color
138	Cottonwood Creek	20.32	12.81	70	41.44	Close, dark brown	Resembles No. 136
139	Prince George	17.27	14.34	70	40.88	White	
141	Pendleton Bay	17.78	21.96	84	36.47	Dark below, white above	Resembles No. 131
142	Pendleton Bay	17.53	27.15	84		White to bronzy	Resembles No. 90 except for bark color
143	Smithers	18.54	22.27	84		Dark brown	Resembles No. 144 except for bark color
144	Smithers	10.16	11.59	84		White	Resembles No. 143 except for bark color
330	Westbank	30.48	13.73	56	36.47	Yellowish brown; exfoliating	
338	Haney	55.88	24.10		40.69	Light, slightly exfoliating	
86	Arnold Arboretum			70		White	Seed from Kallispel, Montana; Arnold Arboretum No. 10557
90	Arnold Arboretum			70		White	Seed from Kaslo, B.C.; Arnold Arboretum No. 12855-1-A.
320	Haines Road, Alaska	55.88	21.35			Bronzy	Similar to No. 124

Determination from two seedlings
[2]Determination from four seedlings
[3]Determination from five seedlings
[4]Determination from six seedlings
[5]Two seedlings with different chromosome numbers
[6]Three seedlings examined; two with 56
[7]Three seedlings examined; two with 70

However, the Fish Lake Road population (Acc. Nos. 119, 120 and 329) distinguished by a uniform somatic chromosome number of 56, very dark brown bark, and small but consistent differences in minor characters from other trees both from British Columbia as well as from other areas, represent a population which may be worthy of varietal status and will be studied further.

Of particular interest is the comparison with the more variable aggregation on the Aleza Lake site, where on a relatively small area, all the different chromosome numbers and bark colors are represented. At the moment it is difficult to equate the members of these two groups with one another, with the large trees growing on the Lower Mainland, with the small white barked trees in the Northern Okanagan, or with the dwarfish, dark barked specimens on Brier Island, Nova Scotia. In attempting to interpret the significance of these observations, we are confronted with what appears to be a highly variable population, maintained in an unstable condition by considerable cross pollination, affording no basis for the separating out of varieties. It may be possible to reach sounder conclusions with respect to the exact significance of the differences noted, by a careful study of trees grown from the seed of these specimens, now established on a common site in the Morgan Arboretum, and with duplicate material provided to the Forest Experiment Station, Chalk River, Ontario, and to the Harrington Forest Farm of the Canadian International Paper Company, Quebec.

One interesting piece of information was given us by a former forest ranger, now a sawmill operator, living in West Central British Columbia, who stated that according to his own experience the "black one" had harder wood, suitable for making skis, tool handles or furniture, as compared with the "white one" which has soft, brittle wood suitable only for firewood. To obtain information on this point, tests for wood quality are to be included in future plans.

Finally, it is hoped that the observations recorded in this paper may point up some of the problems which obviously require more concentrated study over a much longer period of time than could be accomplished by this brief and partial survey. In the meantime, the development of all this material on a common site with soil and climatic factors eliminated will be observed with interest.

ACKNOWLEDGMENTS

Dr. James Marshall, former head of the Entomological Laboratory, Canada Department of Agriculture, Summerland, called our attention to the Fish Lake Road site and greatly assisted in the collection of material in the Okanagan District. We are also indebted to the Canada Department of Forestry, and in particular to Mr. L. A. Smithers for arranging the British Columbia trip and assisting in the actual collection, also his assistant Mr. G. W. Hughes. Mr. P. R. Hellenius of the British Columbia Forest Service first sent us material from Aleza Lake and later helped us with our collections there.

SUMMARY

A morphological and cytological study has been carried out on a collection of *Betula papyrifera* Marsh. from British Columbia in which an analysis has been made of the two varieties which have been distinguished by bark color, namely, *B. papyrifera* var. *commutata* (Regel) Fern. and *B. papyrifera* var. *subcordata* (Rydb.) Sarg. From a correlation of bark color with chromosome number and a consideration of morphological characters, no constant character could be detected between the two color forms other than the single character of bark color. There would appear to be no justification for the retention of the varietal names since there is no recognizable distinction between white- and dark-barked specimens other than color. It would appear appropriate to consider these two types as *formae* rather than as *varietas*, however, the authors feel that no useful purpose is served if it is recognized that, at present, the varietal names distinguish only color forms. Some evidence suggests that bark color may be influenced by environmental factors and the effect of environment on bark color is being investigated. With the exception of one population from Fish Lake Road, characterized by a somatic chromosome number of 56, the other populations were highly variable, presumably as a result of cross pollination, and possessed somatic chromosome numbers of 56, 70 and 84.

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ADDENDUM

Since the foregoing paper was prepared, further observations on the seedlings of certain specimens, including numbers 119, 120, 35-4, 35-5 and 329, indicate that the stems are unlike those of *B. papyrifera* seedlings in that they are thickly beset with glands, and both stems and buds are sticky. These specimens definitely differ from *B. papyrifera* including the large brown-barked coastal forms. They most closely conform to the hybrid species *B.* x *utahensis* Britton as defined by Dugle (Canadian Journal of Botany 44: 929-1007, 1966). However, they are all large single-stemmed trees some of which exceed 15 meters in height as given by Dugle for the upper range in height of this hybrid.

IRIS MISSOURIENSIS NUTT. IN SOUTHWESTERN ALBERTA AND IN CENTRAL AND NORTHERN BRITISH COLUMBIA

B. DE VRIES
Department of Biology, The University of Calgary, Calgary, Alberta*

Iris missouriensis Nutt. was discovered at two separate locations in southwestern Alberta on June 30 and July 1, 1964. Well established populations occur at the margin of shallow depressions in open grassland at low elevations apparently uninfluenced by man. This would indicate that these are natural occurring populations, not a result of human introductions. The Alberta localities (Figure 1) are as follows: 4 miles north of Carway. *2148*, June 30, 1964; 1 mile west of Whiskey Gap. *2149*, July 1, 1964. Specimens presented to the Plant Research Institute, Ottawa, were examined by Dr. B. Boivin who confirmed their identification and first recording for Alberta. Voucher specimens are also in the herbarium of the University of Calgary and in that of the author.

This species ranges from southern California, east to Utah, Arizona and New Mexico, north to North Dakota, Montana and Washington, and occurs in central and northern British Columbia as widely disjunct populations.

The known British Columbia collections (Figure 1) are as follows: Lake Atlin, *Alice Eastwood, 648*, July 14, 1914; Bennett Lake Shore. *D. A. Mitchell, 147*, July 13, 1949; Fraser Lake. *Sills, 9227*, July 1932; Quick Station, *R. Ashford, 162* (*766230*), June 29, 1959; *D. V. Saunders, 30987*, June 23, 1959.

The collection of *Iris missouriensis* by Eastwood in 1914 (Foster 1937) is the first for British Columbia. It is possibly the record on which Abrams (1923) and Rydberg (1917, 1932) based the range from "California . . . to British Columbia". Henry (1915) did not know of this collection, but included the species in his "Flora of Southern British Columbia", on the basis of Piper's (1906) statement: ". . . a station near Coupville is the only one known in the Vancouver strip". Coupville, however, is located on Whitbey Island in the state of Washington.

The unusually wide disjunction between Washington and the central and northern British Columbia stations warrants consideration. The occurrences in central British Columbia: Fraser Lake, and Quick Station, are all contiguous along the railroad in the Endako-Hazelton area, and indicate clearly that the plants have been introduced by man. The other stations at Lake Atlin and Bennett Lake near the Yukon border are also introduced, perhaps by gold miners or early settlers. Tremendous quantities of rhizomes were used in the days of herbal remedies and quack medicines. The colonies in southwestern Alberta, on the other hand, occur in undisturbed native grassland and appear to be northern outliers of the widespread populations in nearby Glacier County, Montana. For these reasons it is considered that they are naturally-ocurring colonies which are not a result of human introduction.

*Present address: Fort Qu'Appelle, Saskatchewan.

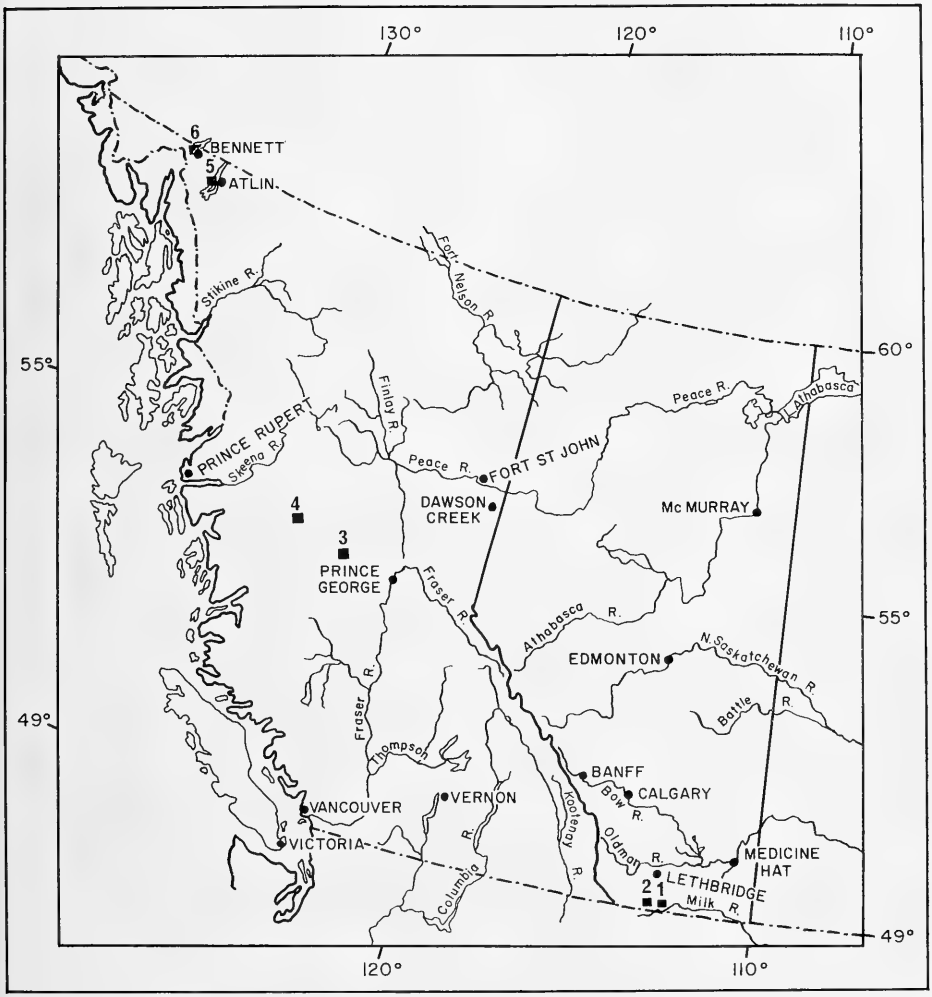

FIGURE 1. Locations of *Iris missouriensis* Nutt, in Southwestern Alberta: (1) Whiskey Gap, (2) Carway; and in Central and Northern British Columbia: (3) Fraser Lake, (4) Quick Station, (5) Lake Atlin, (6) Bennett Lake Shore.

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THE NAMES OF YELLOW BIRCH AND TWO OF ITS VARIETIES

T. C. BRAYSHAW

Department of Forestry of Canada, Petawawa Forest Experiment Station, Chalk River, Ontario*

THE yellow birch was first described by F. A. Michaux (1812) who named it *Betula lutea*. His description was thorough, and accompanied by a clear illustration. Unfortunately, he offended the rules of botanical nomenclature (Lanjouw, 1956) by adding as a synonym, *B. excelsa* Aiton, (Aiton, W., 1789). He thus rendered his own name for this species superfluous and illegitimate from the start. This is true notwithstanding that the type specimen of *B. excelsa* has been found, in fact, not to be our yellow birch. The illegitimacy of *B. lutea* passed unnoticed until Little (1953) drew attention to it by using the more recently published *B. alleghaniensis* Britton as the correct name for this birch, citing *B. lutea* Michx. f. as a synonym.

N. L. Britton (1904) described what he believed to be another species of yellow birch, differing, according to his description, by possessing fruiting scales, or bracts, 4 to 6 millimetres long, and leaves mostly cordate at base; while he distinguished *B. lutea* as having bracts 7 to 8 millimetres long, and leaves rarely cordate. He named his new species *B. alleghaniensis*. Fernald (1922) in reviewing these birches, revealed that Britton's type material was in fact typical *B. lutea* Michx. f.; but he noted that a long-bracted variety does exist. Fernald accepted the older name for this species, and published a new variety, var. *macrolepis*, to include material with bracts 8 to 13 millimetres long.

Although given a lower rank by its author, another variant more conspicuous as a tree in the forest than var. *macrolepis*, is that described by Fassett (1932) as *Betula lutea* forma *fallax*. This epithet, meaning false or deceptive was given to it because its presence in Wisconsin had given rise to erroneous reports of sweet birch (*B. lenta* L.) in that state. Forma *fallax* is distinguished from typical yellow birch by the possession of dark brown bark that typically does not exfoliate into shreds or curly flakes at the surface. The colour

*Present address: 601, 1049 Chilco Street, Vancouver 5, B.C.

difference is especially noticeable when the bark is wet; and the contrast between this dark bark and the light bronzy yellow, shreddy bark of typical yellow birch has misled many people in Canada, including botanists and foresters, to make the same error in identification that Fassett noted in Wisconsin. This has resulted in reports of sweet birch from many places in southern Quebec and Ontario far beyond the restricted range of this species in Canada (Fox and Soper, 1954). The bark of forma *fallax* may however, show some tendency to exfoliate. The bark of sweet birch in Canada is dark ashy grey to jet black, and remains close until it ultimately furrows into hard firm plates or ridges. The bracts of forma *fallax* are ciliate and pubescent, as in typical yellow birch, while those of sweet birch are glabrous.

Owing to the conspicuous nature of the well-named forma *fallax*, and the number of people that have been misled by it, it is thought that this variant should be accorded varietal rank.

Since the name for yellow birch given by Michaux is unuseable, the oldest name applicable to it is *B. alleghaniensis* Britton, as noted by Little. Since neither of the variants mentioned above has been transferred to *B. alleghaniensis*, the revised combinations are here stated as follows:
Betula alleghaniensis Britton, Bull. Torrey bot. Cl. 31: 166. 1904, varietas *macrolepis* (Fernald) comb. nov. (*B. lutea* Michx. f. var. *macrolepis* Fernald, Rhodora 24: 170. 1922); and *B. alleghaniensis* Britton, varietas *fallax* (Fassett) stat. et comb. nov. (*B. lutea* Michx. f. forma *fallax* Fassett, Rhodora 34: 95-96. 1932).

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THE CIRRIPED *STOMATOLEPAS ELEGANS* (COSTA) ON LEATHERBACK TURTLES FROM NOVA SCOTIAN WATERS*

VICTOR A. ZULLO and J. SHERMAN BLEAKNEY
Marine Biological Laboratory, Woods Hole, Massachusetts and
Department of Biology, Acadia University, Wolfville, Nova Scotia

DURING the investigation of sea turtles occurring off the coast of Nova Scotia two leatherbacks (*Dermochelys coriacea coriacea*) were found to host several specimens of the platylepadine barnacle *Stomatolepas elegans* (Costa). The genus *Stomatolepas* has previously been reported only from tropical localities in the American Antilles, the Mediterranean, Japan, and the Malaysian Archipelago. This new occurrence marks not only the highest latitudinal record for the genus, but also the highest latitude from which any platylepadine has been reported.

Although many platylepadines are found exclusively on turtles, they are more closely related to the whale barnacles *Coronula* and *Cryptolepas* than to the "true" turtle barnacle *Chelonibia*. *Stomatolepas* was first described from individuals embedded in the membrane lining the gullet of a loggerhead (*Caretta caretta caretta*) from Tortugas, Florida (Pilsbry, 1910). Subsequently, *Stomatolepas* has been found in the skin of the neck and flippers of loggerheads, and from between the plates of the plastron of the green turtle (*Chelonia mydas*).

The first Nova Scotian *Stomatolepas* were obtained from a 670 lb. male leatherback harpooned off the town of Sambro, Halifax County, on August 21, 1955. The turtle had been retained in a freezing plant at Halifax until August 1964 when one of us (JSB) discovered seven specimens in the skin over the right humerus (Figure 1a). The excellent state of preservation of the internal body structures of the barnacles indicates that the individuals were alive when the turtle was taken.

Four additional fresh specimens were obtained (JSB) from a 1240 lb. female leatherback netted at Seawall, Digby County, on July 20, 1965. Unfortunately, this turtle was held in a pond of low salinity for five days and most of its ectoparasites were either dead or destroyed. Three individuals were found intact in folds of skin on the dorsal surface of the left rear flipper. An additional 29 pits that could probably be attributed to *Stomatolepas elegans* were distributed on all four flippers near the dorsoposterior juncture of flipper and carapace, and another 15 scars were present on the ventral surface of the tail (Figures 1b-c).

The barnacles were almost completely embedded in the skin of the hosts and difficult to excise without separating their fragile wall plates. The shells agree with those figured by Hiro (1936: figs. 1a-b) from a loggerhead (*Caretta olivacea*) taken at Seto, Japan, and Costa (after Pilsbry, 1916: pl. 68, fig. 2)

*Contribution No. 57 of the Systematics-Ecology Program, Marine Biological Laboratory, Woods Hole, Massachusetts.

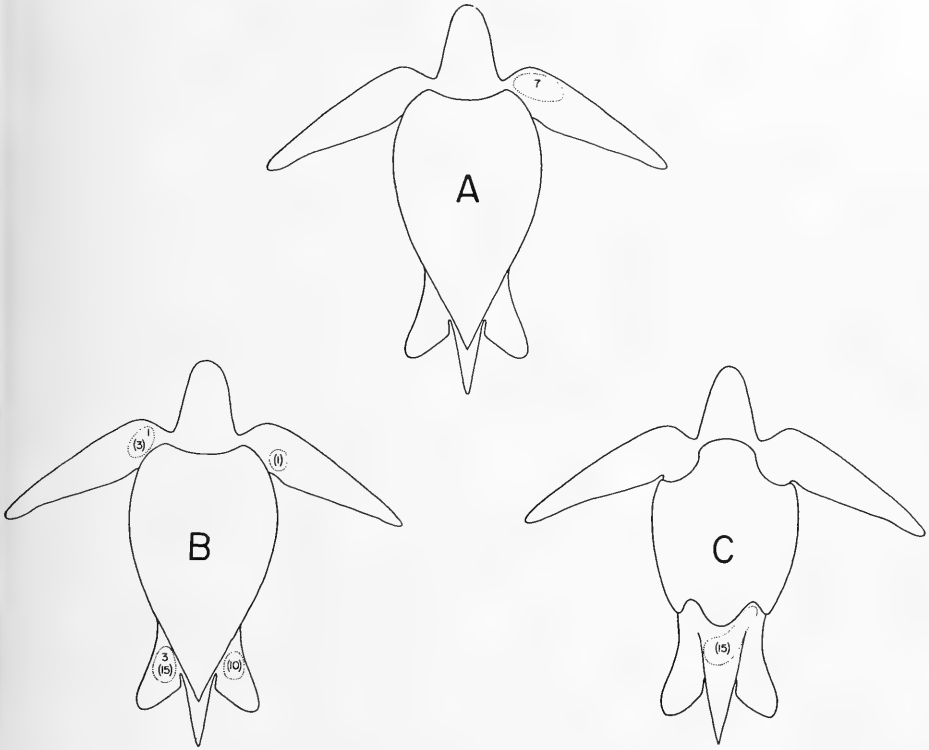

FIGURE 1. Diagrammatic sketches showing the distribution of *Stomatolepas elegans* (Costa) on leatherback turtles from Nova Scotia. *A*, dorsal view of male turtle, Sambro, Halifax County. *B*, dorsal view of female turtle, Seawall, Digby County. *C*, ventral view of same. Numbers indicate individuals, those in parentheses indicate pits or scars.

from an unknown host at Taranto, Italy (Figure 2). From his study of the Japanese specimens Hiro synonymized *Stomatolepas praegustator*, which Pilsbry (1910) had described from Florida, with Costa's older species *S. elegans*.

The distribution of adult *Stomatolepas* is dependent upon the distribution and migration of their hosts. Although marine turtles primarily frequent tropical and subtropical waters, they are not uncommon at higher latitudes (Bleakney, 1965). It is most likely that turtles found in temperate waters are migrants from tropical breeding populations, and there is some evidence for even longer-range movements, especially across the North Atlantic (Caldwell *et al.*, 1959; Carr, 1956; Mowbray and Caldwell, 1958; Caldwell *in lit.*, 1965).

It seems possible that valuable information on the migration and dispersal of marine turtles might be obtained through a study of the barnacles which they host.. Although the systematics, biology and zoogeography of turtle barnacles are scarcely understood, present evidence indicates that such factors as breeding and survival tolerances are attuned to tropical and subtropical conditions. For

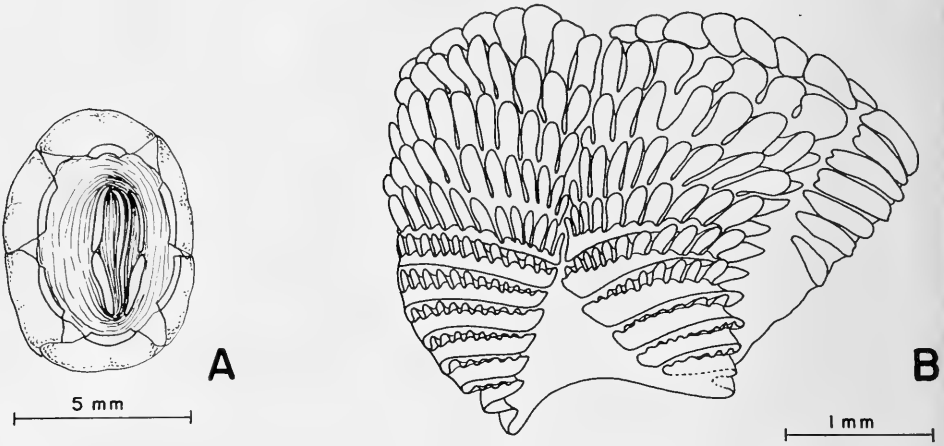

FIGURE 2. *Stomatolepas elegans* (Costa) from male leatherback turtle, Sambro, Halifax County, Nova Scotia. *A*, top view of shell excised from turtle skin. *B*, detail of exterior ornamentation of one of the wall plates.

example, turtle barnacles such as *Chelonibia caretta* (Spengler) and *Platylepas hexastylos* (Fabricius) found on loggerheads taken off Cape Cod, Massachusetts, in summer months are often fouled by the balanid barnacles *Balanus trigonus* Darwin and *B. calidus* Pilsbry. These rock barnacles are common elements of tropical American faunas, and otherwise range northward only to Cape Hatteras in the northwest Atlantic. Hence, it can probably be assumed that the *Stomatolepas* on Nova Scotian leatherbacks also settled in warmer waters, perhaps of the Antillean-Caribbean region, and that subsequently the turtles migrated northward to the area of their capture. Many herpetologists would be particularly interested in knowing whether marine turtles captured off the coast of Europe are ever "tagged' with Caribbean barnacles.

We wish to acknowledge the aid of Dr. David K. Caldwell, Los Angeles County Museum, Los Angeles, California in providing information on the migrations of tropical American turtles; and the Ford Foundation for their support of the preparation of this paper through a grant to the Systematics-Ecology Program.

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CORRECTION NOTE

The following table was omitted from the article *A study of waterfowl nesting on the Saskatchewan River delta* by Gerald H. Townsend which appeared in *The Canadian Field-Naturalist* 80(2): 74-88. This table should have appeared on page 85.

TABLE 6. — Mean distances of nests from large water compared with predation rates on nests. Confidence limits are at the 95% level.

Species	Nests	Distance (feet)	Predation rate
Canvasback	8	10 ± 10	0
Lesser Scaup	83	55 ± 30	33 ± 10
Ring-necked Duck	46	83 ± 30	20 ± 12
Mallard	12	83 ± 30	42 ± 31
Blue-winged Teal	27	104 ± 46	48 ± 20
Gadwall	6	105 ± 50	33 ± 49

VEGETATION OF COTTONWOOD FORESTS ON KODIAK ISLAND

Edward W. Beals
University of Wisconsin, Madison, Wisconsin

Forests dominated by black cottonwood (*Populus trichocarpa*) occur in suitable localities around the coast of Kodiak Island, Alaska. Hanson (1961) described one such stand in northern Kodiak in his survey. Along the northern coast of Kodiak spruce (*Picea sitchensis*) forests occur, but farther south, cottonwoods form the only type of forest, a distinctive contrast to the grassy meadows and marshes around them. The work reported here was carried out in the summer of 1961 along the southeastern coast of Kodiak Island. *Populus trichocarpa* communities elsewhere in western North America have been described by Lynch (1955) for Montana and by Smith (1957) for British Columbia.

The Environment

Kodiak Island receives considerable rainfall the year around; at the town of Kodiak, 40 miles north of the study area, average annual precipitation is over 60 inches, fairly evenly distributed throughout the year (averaging 3.6 inches for the driest month, July). July mean temperature is 54° F; that of January is 30°. The average dates of last and first killing frosts are May 5 and October 12. (Data from the U.S.D.A. 1941.)

The forests are restricted to relatively protected sites, never where directly exposed to the open ocean. They are thus protected somewhat from salt spray. They occur mostly on the northern and eastern shores of the bays and straits rather than on southern. The montainous terrain therefore provides some protection from winter northerly winds.

Most often the forests are found at the mouths of perennial streams, but some are located where there are only intermittent streams or even none at all. The streams characteristically flow rather steeply down the mountains and just before reaching the ocean form a small alluvial plain, where the forests are usually found. The alluvium is a gravelly, sandy silt, often covered with several inches of litter.

Field Methods

Five stands were sampled:

SB: northwest side of Shearwater Bay, ½ mile west of Kadiak Fisheries; dry ravine.
KB: north side of Kiliuda Bay at Shearwater Bay, 1 mile west of Kadiak Fisheries; south slope of hill (Figure 1).
BP: Bush point, northern Sitkalidak Strait; alluvium.
BB: head of Barling Bay; alluvium.
TSB: head of north finger of Three Saints Bay; alluvium.

FIGURE 1. View of a cottonwood forest on a drier site (stand KB). Note the density of herb and shrub layers, and the dark color of tree trunks due to epiphytic mosses.

TABLE 1.—Relative density of trees and of tall shrubs

	Stands				
	KB	SB	TSB	BP	BB
Trees					
Populus trichocarpa	100%	95%	88%	93%	99%
Alnus crispa	—	—	9	6	—
Betula kenaica	—	1	—	—	—
Salix barclayi	—	—	3	—	1
Salix glauca	—	4	—	1	—
Shrubs					
Alnus crispa	—	1	43	19	1
Betula kenaica	—	4	—	—	—
Oplopanax horridus	3	—	13	1	—
Populus trichocarpa	23	11	—	10	15
Rosa nutkana	3	26	—	—	—
Rubus spectabilis	16	4	23	3	—
Salix alaxensis	—	—	—	1	6
Salix barclayi	—	6	3	14	36
Salix glauca	3	26	9	8	—
Sambucus racemosa	10	8	8	38	31
Viburnum edule	44	14	4	8	10
Density per acre					
Trees	136	142	262	93	104
Shrubs	132	174	1295	371	189
Basal Area sq ft/acre					
Populus trichocarpa	116	119	95	111	109

Twenty sampling points per stand were located 30 paces (about 70 feet) apart. There was some bias in selecting the points due to the dense shrub layer and a consequent tendency to pace along bear trails. Trees (4 inches DBH or larger) were sampled by the quarter method (Cottam and Curtis 1956), as also were the tall shrubs (woody plants five feet or taller but smaller than trees). Quadrats of one square meter were laid out, and species of the smaller shrubs and of the herbs listed. Basal area of trees was estimated by the Bitterlich method, using a prism with BA factor 10 (Bruce 1955).

Plant names in this paper follow Hulton (1940-1950).

RESULTS

Table 1 shows the data for the tree and shrub layers. All stands were dominated by cottonwood trees. Stand TSB differed from other stands in regard to its much higher shrub density and by the abundance of alder (*Alnus crispa*).

Table 2 shows the frequency of all herb and shrub species occurring in at least five quadrats of the stands combined. Three stands, BP, BB, TSB, were associated with permanent streams, while the stands KB and SB were not. The stands were divided into two groups (the two drier ones and the three with streams) and a χ^2 test of homogeneity was applied to the more common species. Where an expected value was less than five but significance suspected, Fisher's exact method (1958) was used to determine probability. On this basis the

TABLE 2.—Frequencies of common herbs and smaller woody plants

	Stands				
	KB	SB	TSB	BP	BB
Associated with drier sites					
Cerastium beeringianum	15	25	—	—	—
Dryopteris austriaca	100	75	35	70	30
Equisetum arvense	5	20	—	—	—
Pyrola asarifolia	40	50	—	10	25
Rubus spectabilis	60	15	30	5	10
Veratrum eschscholtzii	50	10	—	—	—
Not significantly associated					
Angelica lucida	25	60	35	70	80
Calamagrostis canadensis	70	70	95	80	75
Cystopteris fragilis	15	5	—	5	10
Dryopteris linneana	35	90	85	45	50
Epilobium angustifolium	55	85	50	60	80
Galium boreale	5	10	—	25	5
Galium trifidum	5	35	—	50	65
Geranium erianthum	—	15	5	10	15
Sanguisorba sitchensis	—	15	5	—	20
Streptopus amplexifolius	15	—	10	—	10
Thalictrum sparsiflorum	—	10	—	—	25
Associated with wetter sites					
Chenopodium capitatum	—	—	40	—	5
Circaea alpina	40	25	85	80	40
Claytonia sibirica	—	5	15	25	30
Geum macrophyllum	—	—	15	50	40
Heracleum lanatum	15	10	50	15	35
Ranunculus sp.	—	—	5	5	20
Solidago multiradiata	—	—	—	5	40
Trientalis europaea	—	15	30	15	30
Total No. Species in Quadrats	20	22	23	30	27
Ave . No. Species per Quadrat	5.8	6.7	6.4	7.1	7.8

species were divided into three groups in Table 2: those significantly associated with drier sites, those not significantly associated with either, those significantly associated with wetter sites. A larger sample might have reduced the number of species in the middle group, although some would very likely have still shown little preference. Of the shrubs, *Alnus*, *Salix alaxensis* and *S. barclayi* prefer wetter sites, while *Rosa*, *Salix glauca* and *Viburnum* prefer drier sites.

DISCUSSION

The luxuriant growth of these forests is remarkable in view of the very cool temperatures that persist throughout the growing season. The reason lies in the favorable rainfall – adequate moisture at almost all times. This is reflected also in the heavy epiphytic vegetation of mosses that often completely covers the trunks and larger branches of the cottonwoods (Figure 1), and the not uncommon occurrence of vascular plants, especially the fern *Dryopteris austriaca*, as an epiphyte in the crotch of a tree. Mosses on the ground are not abundant because of the density of shrub and herb layers, and the heavy leaf litter.

The climate is likely favorable enough to support more kinds of forests. The usual explanation for the tall-grass meadows, characteristic of undisturbed areas at lower altitudes on Kodiak and the Alaska Peninsula, is that of time-lag between change in climate and migration of forest trees. The forests of *Picea sitchensis* on northern Kodiak have been advancing into this grassland (Griggs 1934), and personal observations in 1961 suggest that the advance continues. Since the seeds of spruce have a relatively low rate of dispersal, and since pioneer spruce seedlings in the open are somewhat retarded by their exposure, it may be that the change in climate since glacial times has occurred more rapidly than the expansion of spruce forest could occur.

The cottonwoods, whose seeds are very widely dispersed by the wind, have succeeded in establishing themselves over the island in favorable sites. The cottonwood stand studied by Hanson (1951) on northern Kodiak had in the shrub layer saplings of *Picea sitchensis*. It is possible then that, given a seed source, spruce might eventually replace the cottonwoods on the higher, better-drained sites or as soil is built up on the alluvial sites. Elsewhere in southern Alaska cottonwoods are more restricted to the vicinity of river valleys than here, and their presence here on the drier sites may be due to lack of competition with spruce.

From the data, cottonwood reproduction seemed adequate in all the stands except TSB. This stand differed from others in its high density of trees and especially of shrubs, with *Alnus* predominating. On the other hand it had the lowest basal area per acre, indicating that the trees were much smaller than those in other stands. It was very likely a much younger stand, in which the pioneer shrubs were still very conspicuous. Although no cottonwood saplings were recorded at the sample points, there were some in the forest. (By the nature of the quarter method, the very high density of *Alnus* and *Rubus* made the lower density of *Populus* more impressive.) In a mature forest a large proportion of saplings probably comes from root sprouts (as reported in British Columbia by Smith, 1957). In a young forest, where trees are themselves still growing rapidly, such sprouts would probably be less frequent. As the stand matures, *Populus* reproduction will most likely increase and be adequate to replace dying trees.

In conclusion, several further points can be made:

These forests consist of two well developed woody layers, a tree layer 30-60 feet high and a tall-shrub layer 5-10 feet. In addition, two predominantly herbaceaus layers occur. Prominent in the upper one (3-6 feet) are *Angelica, Calamagrostis, Epilobium, Heracleum, Veratrum*; in the lower one (1 foot or less), *Circaea alpina, Dryopteris* spp., *Galium* spp., *Pyrola.*

There is a negative correlation between basal area and shrub density. As basal area is closely correlated with canopy, this relationship would be expected.

Except for the young stand discussed above, the wetter stands have lower density of trees and higher density of shrubs than do the drier stands.

There is an increase in species diversity from dry to wet sites, both as expressed in total number of species in each stand and in the average number of species in each quadrat (Table 2, bottom).

ACKNOWLEDGMENTS

The trip to Kodiak was financed by the Departments of Anthropology and Zoology, University of Wisconsin, with National Science Foundation funds. Richard Nelson assisted with the field work for this study.

SUMMARY

Five stands dominated by *Populus trichocarpa* were sampled along the southeast coast of Kodiak Island, Alaska. The wetter sites generally had fewer trees, more shrubs, and greater species diversity than the drier. Some species of herbs and shrubs showed distinct moisture preferences, others did not. Well-distributed rainfall produces a very luxurious vegetation of four strata, with abundance of epiphytic mosses.

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CORRECTION NOTE

In the article by A. H. Macpherson in *The Canadian Field-Naturalist* 80 (2): 89-94, the figures above the legends reading Figure 2 (p. 92) and Figure 3 (p. 94) were reversed. This transposition was corrected in reprints issued of this article.—EDITOR

REVIEWS

Arachnida

By Theodore Savory. Academic Press, London and New York, 1964. viii + 291 pages; 109 figures. Price about $9.50 Canadian.

The book is divided into 40 chapters and treats in one way or another, almost all aspects of Arachnology.

The chapters are arranged into six groups. The first is a short discussion on arthropods in general. The second discusses the class Arachnida, and includes morphology, physiology, embryology, ontogeny, bionomics, ethology, ecology, phylogeny and taxonomy. The third discusses all the orders of Arachnida, including the fossil orders. Mr. Savory considers that there are 16 arachnid orders, five of which are represented only by fossils.

The fourth group mentions the doubtful Arachnida, namely Merostomata and Pycnogonida. The fifth group discusses historical, practical, chemical and scientific arachnology. And the sixth group is a heterogenous collection of subjects including the spider's web, courtship, arachnophobia, arachnids in amber, arachnid venom, and "Disiecta Membra". The book concludes with a list of general and selected references on arachnids for the interested reader.

Upon reading the publisher's announcement for this book, one is given the impression that at last we have an English version of Tome 6 of Grassé's *Traite de Zoologie*, or a completely revised and updated edition of Savory's own *The Arachnida*, but the reader will be disappointed.

This book contributes very little to Arachnology as it contains little information that cannot be found in any one of several books, including the two just mentioned above, and Barne's *Invertebrate Zoology*. In fact, there is very little difference between *Arachnida* and *The Arachnida*, which was published in 1935. Almost all the figures are the same, but all the photographs in the 1935 book have been excluded in this book.

The proof reading for *Arachnida* was poorly done, as is evident by the many typographical errors throughout the text, and the taxonomy is some 15 to 20 years out of date, especially in the Acari.

The real need in Arachnology is for a comprehensive text book that covers both generalities for the beginner and some detail for the specialist. *Arachnida* satisfies neither of these conditions.

The quality of binding and printing is good, but the black and gold paint outlining the title on the spine comes off with little use of the book. It is this reviewer's opinion that the book is not worth its cost.

Robin Leech

Entomology Research Institute
Canada Department of Agriculture
Ottawa, Ontario

Physiology of Mollusca, Volume 1

Edited by Karl M. Wilbur and C. M. Yonge. Academic Press Inc., Publishers, 111 Fifth Avenue, New York, 1964. xiii + 473 pp., numerous plates, octavo. $16.00 (U.S.).

Assembled together in this impressive volume are thirteen superbly written, thoroughly documented, review articles, by fourteen of the world's most highly regarded experts, summarizing the present state of scientific knowledge concerning many of the most important aspects of molluscan physiology. This volume is a landmark in its field and, of course, it will be indispensable to all students of molluscan physiology. But in addition to physiology in the usual sense, a number of topics are discussed which are not customarily included as parts of the subject matter of that

science. Because of this broad scope the book will also be of vital concern to all who are interested in the evolution, ecology, reproduction, growth, or culture of mollusks. And this includes nearly everyone with an amateur interest in malacology or with an academic interest in molluscan biology.

The subjects covered in Volume 1 are as follows: classification and structure of the Mollusca, physiological aspects of the ecology of intertidal molluscs, physiological aspects of the ecology of nonmarine molluscs, reproduction, development, the culture of marine bivalve larvae, growth, shell formation and regeneration, osmotic and ionic regulation, muscle and neuromuscular physiology, and special effectors (luminous organs, chromatophores, pigments, and poison glands). Contributing authors include such well-known scholars as Vera Fretter, Alistair Graham, W. Russell Hunter, J. E. Morton, Gareth Owen, C. P. Raven, C. M. Yonge, and others.

For a researcher working on molluscan ecology, zoogeography, or evolution, or on economic mollusks, this book is of tremendous value because it summarizes in succinct form (with references) so much specialized information, largely from the European literature, with which he is probably not familiar. The zoogeography of Canadian mollusks, for example, is bound up not only with glacial and postglacial geological and climatic events but also with innumerable physiological aspects of ecology, reproduction, development, etc. which must be considered in depth. Numerous other examples of the well-known interdependence of supposedly separate branches of science could be cited. It is clear, however, that physiology in all of its aspects is fundamental to an understanding of all other branches of biology; and since this volume is by far the most authoritative and complete source of information available on molluscan physiology no interested student should be without access to it.

Volume 2, which will complete the set, will include sections on feeding, digestion, metabolism, blood circulation, excretion, and the nervous system of mollusks, all written by a distinguished group of specialists. Three sections will deal specifically with cephalopods which, because they are phylogenetically the most advanced group, are the most complex physiologically. All workers in malacology owe a debt of gratitude to the editors for making such a wealth of information available in such easily available form. Let us hope that Volume 2 will appear soon.

A. H. CLARKE, JR.

National Museum of Canada
Ottawa, Ontario

Fishes of the Western North Atlantic, Part 5, Order Iniomi and Order Lyomeri.

Order Iniomi, characters and synopsis of families by W. A. GOSLINE, N. B. MARSHALL and G. W. MEAD; Aulopidae — G. W. MEAD; Synodontidae — W. W. ANDERSON, J. W. GEHRINGER and F. H. BERRY; Bathysauridae, Bathypteroidae, Ipnopidae and Chlorophthalmidae — G. W. MEAD; Mytophidae and Neoscopelidae (interim accounts) — R. L. BOLIN; Scopelosauridae — N. B. MARSHALL; Paralepididae, Omosudidae, Anotopteridae, Evermannellidae, Scopelarchidae — R. R. ROFEN; Alepisauridae — R. H. GIBBS, JR.; Order Lyomeri —J. E. BÖHLKE. Memoir Sears Foundation for Marine Research, (1), part 5:1-647, 220 fig., New Haven, 1966.

Bizarre bathypelagic fishes finely figured, distribution maps and depth range graphs and a wealth of information brought together on iniomous fishes and deep-sea gulpers make this a particularly exciting volume. The text matches the fine quality of the format.

Some comments on individual sections may be noted. A noteworthy inclusion is the excellent discussion defining the Iniomi. The reviewer agrees that they form a natural group and are worthy of

ordinal recognition. To the definition of this order might be added the possession of 4 branchiostegals on the external face of the hyoid arch with the rest ventral or internal (reviewer, ms) and the possession of retractores arcuum branchialium muscles (Holstvoogd, 1965; *see* Koninkl. Nederlandsche Akademie Van Wetenschappen, Amsterdam, Proceedings 68: 209). These two characters, plus the fusion of the inner pelvic ray to the pterygiophore, indicate that this order has affinities with the spiny-rayed fishes. The suborders Myctophoidei and Alepisauroidei, usually recognized, are rejected in this treatment. Especially noteworthy are the accounts of families by Mead and by Rofen. Some, praiseworthy systematically, fall short in life history aspects. For example, although the study material of a species, in one case, included 98 specimens, not one was opened to discover its feeding habits. It is unfortunate that Böhlke did not have the opportunity of adding to his account on the Lyomeri after the publication of Orton's (1963) findings. The date of publication of *Paralepis* (=*Notolepis*) *rissoi* is given as 1841, but Salvadori (1888, *see* National Museum of Canada Bulletin 168: 14) indicates that it was 1840. Taxonomic changes are made in all the paralepids known from the Atlantic coast of Canada. *Bathypterois viridensis* is reported for the first time in Canadian waters. The most recent reference appears to be 1963; an indication of the date of submission of the papers would protect the author and inform the reader.

Some general observations on the volume may be noted. The accounts attain a high level of scholarship in this volume. The editing has been thorough, only a single misspelling was noted. The addition of spot distribution maps to most accounts is very worthwhile and one hopes that this will become standard. Small touches such as including pagination in the keys and capitalizing key words like GAS BLADDER in the text are commendable. Out of keeping with the high standard is the failure to cite the titles of papers in the list of references. Authors in this volume, unlike some of those in previous ones, have studied large series of specimens. As usual Canadian literature is not well covered (e.g. Paralepididae, Anotopteridae, Eurypharyngidae).

Family descriptions are not standardized. This makes it difficult to compare characters in different families. Perhaps, in the future, an editor could recommend a format for family descriptions, at least for the larger orders. Fossil groups are ignored in most accounts. Two recommendations of the International Code of Zoological Nomenclature are not followed. Firstly, that in citing a binomen a comma separate the author's name and the date of publication. Secondly, that in synonymies the author's name follow the binomen uninterrupted by punctuation only when it is the original description; otherwise it be separated by a punctuation mark (other than a comma), such as a colon. The latter is a useful practice distinguishing original descriptions from subsequent identifications.

The first part of the series is now out of print. As the reviewer suggested previously, consideration should be given to a quality reprint of reduced size (as has been done with Bent's life histories of North American birds). A reprint of the sturgeon section by the Quebec Department of Tourism, Fish and Game Branch, shows that this can be done without great loss of quality in the figures. Consideration might also be given to printing separately full-sized prints of some of the finer figures. These would be suitable for framing and might help avoid mutilation of the volumes by print collectors. Some, such as figure 200 of *Evermannella indica* by Eva Maria Soule, are well-worthy of framing.

D. E. McALLISTER

National Museum of Canada
Ottawa 4, Ontario

Catalogue Systématique des Noms de Genres de Poissons Actuels

By YVES-J. GOLVAN. Masson et Cie, Editeurs, Paris. 1965. 227 pp.

This catalogue attempts to summarize all the subgeneric and generic names applied to living species of fishes, from 1758 to the end of 1959. The genera are listed alphabetically under family; the families are arranged according to the classification in the Traité de Zoologie. The author(s) and date of publication are given for each genus. Genera believed to be valid are printed in boldface, while genera which are junior synonyms, homonyms, or emendations are printed in italics, and are followed by the valid name. At the end of the volume is an index to the genera included in the volume. Three new names are published: Paraclinidae (p. 129), Scytaliscidae (p. 133), and Aeschynichthyidae (p. 173).

The volume includes about 9000 generic names for living fishes, valid and invalid. This represents a considerable increase over the about 7000 generic names for both living and fossil fishes, valid and invalid, in Jordan's *The classification of fishes,* published in 1923 (Linnaeus used only about 50 genera). It also represents a considerable portion of the generic names applied to all the vertebrates – about 17,000 (Y. J. Golvan, 1965, *Répertoire des noms de genres de vertébrés*). A sampling of 11 half pages of Golvan shows 205 out of 297 genera, or 69% to be valid. If this sample was representative, there would have been about 6,200 valid generic names for fishes in 1959.

The value of the volume is readily apparent. If one wishes to know who published a generic name at what time, where a genus is placed or how it is properly spelled, the answer can readily be found in Golvan. Criticisms are that the classification is oversplit, there are omissions (*Pomadasys, Plectobranchus,* etc.) and archaisms (*Uranidia* is not synonymized with *Cottus*). Many errors could have been avoided had taxonomic ichthyologists been involved. On the other hand we are indebted to a parasitologist, Golvan, for a valuable handbook that no recent ichthyologist has been brave enough to prepare.

D. E. MCALLISTER

National Museum of Canada
Ottawa, Ontario

Raccoons and Eagles

By POLLY REDFORD. E. P. Dutton and Co. Inc., New York, 1965. Clarke, Irwin and Company Limited, Toronto. 254 pp. $5.50.

In his foreword Carl Buchheister, President of the National Audubon Society points out that raccoons and eagles are uniquely American, which is the reason they are included in one book.

The two species are separately treated in the book with more than 100 pages devoted to each one. In the last few pages the two are brought together as part of a forceful message on conservation.

The author has combined up-to-date biological information, which has rather surprising gaps, with the history, politics, symbolism and folklore in which the two species are involved.

Her story ranges from her personal experiences in raccoon raising and eagle watching, through the vagaries of the fur industry, to the decline in eagle numbers through pesticide poisoning. There are warnings of future problems of species decline and true stories of wildlife research by earnest professionals and eager amateurs. Through it all the book is uniformly well written and attractive to read.

Mrs. Redford's closing paragraph deserves our careful attention.

> "Long ago it was said that not even a sparrow was too small or too worthless to fall unnoticed. No living thing is worthless just because we happen to

have no use for it at the moment. Now an eagle is falling. And unlike those other symbols of dying wildlife — the condor, the ivory-billed woodpecker, and the famous whooping crane — bald eagles are not specialized creatures of restricted range. They are (or were) strong, hardy birds that range throughout North America. When they die, it will be because this continent is no longer fit for a wild, free-moving thing to live. In this, our threatened eagle symbolizes America in a way it never has before. If we lose him we shall have lost more than a bird."

V. E. F. SOLMAN

Canadian Wildlife Service
Ottawa, Ontario

A Monograph of Lemnaceae

By EDWIN H. DAUBS. Illinois Biological Monographs 34, University of Illinois Press, Urbana. 31 December, 1965. 118 pp., 21 plates of line drawings and maps. $3.50, in cloth $4.50.

This world-wide work reviews, in a technical and most competent manner, the taxonomy of the 28 species composing this family of minute and structurally simple aquatic plants, the smallest flowering plants known. Most species are tropical and become prolific on warm stagnant waters by rapid vegetative budding. Five of the wide-ranging species extend into southern Canada: the three common duckweeds, *Lemna minor*, *L. trisulca* and *Spirodela polyrhiza*, and two less conspicuous watermeals, *Wolffia columbiana* and *W. punctata*. Their distribution as given on the world-scale maps cannot show the details of occurrence and only a few specimens are cited for Canada out of the many thousands that the author has examined. A separate listing is made of the specimens in flower or fruit, a very rare condition not yet known for some species.

An extensive bibliography includes titles on morphology, physiology and local geography, as well as on taxonomy, and this compilation will prove most useful to those whose interests lie more in the natural history and wildlife aspects of water scums. The plants are being used more and more in laboratory experiments, so easily can they be handled, cultured and counted.

W. G. DORE

Plant Research Institute
Department of Agriculture, Ottawa

OTHER NEW TITLES

Northern Foxe Basin, an area economic survey, 1965

By G. ANDERS. Industrial Division, Northern Administration Branch, Department of Northern Affairs and National Resources. Mimeographed. 1966. 139 pp.

Banks Island, an area economic study, 1965

By P. J. USHER. Industrial Division, Northern Administration Branch, Department of Northern Affairs and National Resources. Mimeographed. 1966. 125 pp.

These reports are published in their present form primarily for use within the Department, for distribution to other interested Government agencies, and for limited distribution to universities, organizations and individuals actively interested in northern affairs. Each contains an account of the utilization of the wildlife present in the area.

Annuals and Biennials

By ROY HAY. An Ilford Colour Book of Flower Identification. Edbury Press in association with George Rainbird. 1966. 112 pp. *In Canada*: Thomas Nelson & Sons (Canada) Ltd., Toronto. $3.00.

Flowering Bulbs, Corms and Tubers

By FRANCES PERRY. An Ilford Colour Book of Flower Identification. Edbury Pressin association with George Rainbird. 1966. 112 pp. *In Canada*: Thomas Nelson & Sons (Canada) Ltd., Toronto. $3.00.

These slender volumes with a minimum of text description and gardening directions are lavishly illustrated with 96 plant portraits each – all in full glossy colour. A modest delight for any gardner or anyone who appreciates flower photography.

Audubon in the West

Compiled, edited and with an Introduction by JOHN FRANCIS MCDERMOTT. University of Oklahoma Press, Norman. 1965. 131 pp. *In Canada*: Burns & MacEachern Ltd., Don Mills, Ontario. $6.00.

A collection of twenty letters by Audubon to his family and friends on his last lengthy journey – in 1843 into the interior of North America to the Upper Missouri country to collect and paint mammals for his "Viviparous Quadrupeds of North America". The letters cover the period from Wheeling, Virginia, March 16 to Fort Union, Upper Missouri, June 17. Eighteen plates are included with the text – mostly of scenes by painters of the period, although a portrait of Audubon, facsimile of his signature and a couple of his drawings are included in the selection.

Children as Naturalists

By MARGARET M. HUTCHINSON. Allen & Unwin Ltd., London. Second Edition. 1966. 190 pp. *In Canada*: Thomas Nelson & Sons (Canada) Ltd., Toronto. $5.00.

This fine little British book, written by a teacher for teachers, contains much of value to anyone trying to spark an interest in and appreciation of natural history in children. Although the examples are drawn from the English countryside, a North American reader should have no difficulty in finding the equivalents for use in the same types of projects and problems in this continent.

The Primates

By SAREL EIMERL and IRVEN DE VORE and THE EDITORS OF LIFE. Life Nature Library, Time Inc., N.Y., 1965. 199 pp.

Animal Behavior

By NIKO TINBERGEN and THE EDITORS OF LIFE. Life Nature Library, Time Inc., N.Y., 1965. 199 pp.

Early Man

By F. CLARK HOWELL and THE EDITORS OF LIFE. Life Nature Library, Time Inc., 1965. 200 pp.

A Guide to the Natural World and Index to the Life Nature Library

By THE EDITORS OF LIFE. Time Inc., N.Y., 1965. 210 pp.

These volumes should require no comment so well received and popular has this fine series proven. The final volume is a condensed classification of one-celled creatures (Monerans and Protistans), animals, plants and minerals as well as an index to the entire series.

Tree Flowers of Forest, Park and Street

By WALTER E. ROGERS with drawings by OLGA A. SMITH. Dover Publications, reprint 1965 of 1935 edition. *In Canada*: General Publishing Co. Ltd., Don Mills, Ontario. $3.45.

One hundred and twenty-one arboreal species are depicted by full-page silhouettes of winter outline, sketches of leaf form and tree flowers, and magnified photographs of the flower. A brief account of special features of each plant illustrated is included. Thirty-three families are represented.

NOTES

Additional Bird Observations at Bathurst Inlet, N.W.T.

From May 14 to September 6, 1950, E. H. McEwen and I recorded the birds seen during our stay at Bathurst Inlet, Northwest Territories, and those records later were published (McEwen, 1957). Subsequently, I spent two additional periods there during which trips were made through the high, rough country (up to 2,000 ft. elevation above sea-level) on both sides of the Inlet. Those visits were from June 2 to July 2, 1951, and from June 2 to June 27, 1954. Field assistance was provided by N. G. Perret in 1951 and A. Radvanyi in 1954, both now of the Canadian Wildlife Service. McEwen recorded 50 species of birds seen or reported, 20 species nesting, and 14 species probably nesting. All birds recorded by McEwen were seen again in 1951 and 1954 with the exception of Greater Scaup (*Aythya marila*), Bufflehead (*Bucephala albeola*) and American Robin (*Turdus migratorius*). McEwen's remarks regarding numerical and nesting status of most species were confirmed, although a few, notably the Red-breasted Merganser (*Mergus serrator*), Golden Eagle (*Aquila chrysaëtos*), Ruddy Turnstone (*Arenaria interpres*) and Snow Bunting (*Plectrophenax nivalis*) were seen in greater abundance, or more frequently, in the later years. This seemed entirely due to their being more abundant in the high inland country not visited in 1950. Ravens (*Corvus corax*) were much more abundant in high country occupied by calving caribou, among which they were doubtless scavenging, than in coastal areas. Several flocks were seen, the largest being 24 birds on June 14, 1951, suggesting a considerable population of non-breeding birds following the caribou. At Bathurst Inlet young Ravens were not flying until the last few days of June. The 1951 and 1954 records include five new species seen, authentication by residents of Bathurst Inlet of a species reported by Snyder (1957), and one species seen in 1950 but omitted by McEwen. Also included are one new nesting record, and a listing of spring arrival dates earlier than those observed in 1950.

Yellow-billed Loon *Gavia adamsii.* First seen June 6, 1951, and June 4, 1954. (McEwen, June 15, 1950).

Pacific Loon *Gavia arctica.* First seen June 6, 1951, and June 11, 1954. (McEwen, June 13, 1950).

Red-throated Loon *Gavia stellata.* First seen on June 5, 1951, and June 17, 1954. (McEwen, June 19, 1950). A nest with two eggs was found June 27, 1951, on the Burnside River delta.

Gyrfalcon *Falco rusticolus.* New species. One bird defending a nesting territory on an inaccessible cliff was seen 10 miles inland from Burnside Harbour, June 14, 1951.

Willow Ptarmigan *Lagopus lagopus.* New species. McEwen recorded only the Rock Ptarmigan (*Lagopus mutus*), but a Willow Ptarmigan was shot at Burnside Harbour in June, 1951. Several of the many ptarmigan seen in 1951 and 1954 were believed to be of the latter species.

Whopping Crane *Grus americana.* New species. A bird was seen June 13, 1954, flying northward in a river valley about eight miles west of Bathurst Inlet and could scarcely have been any other

species. It was studied by Radvanyi and the author, through 7 x 50 binoculars, and was obviously a large white crane with black wing tips.

SEMIPALMATED PLOVER *Charadrius semipalmatus*. Apparently nesting when first observed on June 5, 1951. (McEwen, first observed June 9, 1950; first evidence of nesting July 4, 1950).

HUDSONIAN GODWIT *Limosa haemastica*. New species. Although not recorded by McEwen, a single bird was seen on the Burnside River delta June 26, 1950.

NORTHERN PHALAROPE *Lobipes lobatus*. First seen on June 4, 1954 (McEwen, June 15, 1950).

RED PHALAROPE *Phalaropus fulicarius*. New species. A single female was observed and photographed on the Burnside River delta June 24, 1954.

PARASITIC JAEGER *Stercorarius parasiticus*. New species. Single birds were seen June 9 and 19, 1954, both being in the light phase. Unidentified jaegers were seen several times in each year of observation, most frequently flying northward up Bathurst Inlet at some distance from land. Several did not appear to be bulky enough to be Pomarine Jaegers (*Stercorarius pomarinus*), the most common species in the region.

SNOWY OWL *Nyctea scandiaca*. Identified in 1950 only from the remains of a single bird. Live individuals were seen June 5 and 13, 1951.

EASTERN KINGBIRD *Tyrannus tyrannus*. New species. A single bird, obviously a stray, was collected in June, 1953 on the Burnside River flats and is now deposited in the Royal Ontario Museum (Snyder, 1957).

GREY-CHEEKED THRUSH *Hylocichla minima*. First seen June 11, 1951, and June 9, 1954. (McEwen, about June 13, 1950).

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JOHN P. KELSALL

Canadian Wildlife Service,
Edmonton, Alberta
28 October 1965

Incubation Periods of Some Subarctic Birds

SINCE 1930, the Churchill, Manitoba, region has received much attention from ornithologists. However, despite the great amount of field work that has been carried out there, basic aspects of the breeding biology of many Churchill birds are still poorly known. During field studies in this area, Jehl in 1964 and 1965, Hussell in 1965, we gathered some data on the incubation periods of 15 species, which we present here. Although we have not made a complete search of the literature, it appears that for at least six of these species there are no previously reported incubation periods, and for several other species the available data are sparse or imprecise. Eggs were code marked with indelible ink in order of their appearance in the nest. Unless otherwise noted, all incubation periods are calculated from the laying to the hatching of the last egg in the clutch.

We gratefully acknowledge the field assistance given us by Charles G. Yarbrough, and David F. Parmelee and party, in 1964; and by Robert W. Stamp in 1965. W. Earl Godfrey kindly informed us of data regarding the incubation periods of several species. Field work was supported by grants from the Frank M. Chapman Memorial Fund and from the National Science Foundation.

Semipalmated Plover, *Charadrius semipalmatus* — Incubation periods of 23 and 25 days.

Whimbrel, *Numenius phaeopus*—Periods of 22 and 23½ days recorded; another nest was incubated at least 22½ days. There are apparently no previous data for the New World population of this species (W. E. Godfrey, *in litt.*).

Common Snipe, *Capella gallinago* — One nest, 19 days.

Short-billed Dowitcher, *Limnodromus griseus* — Incubation period at a nest discovered by Parmelee was 21 days (maximum error, 6 hours). This is the first reported incubation period for this species.

Least Sandpiper, *Erolia minutilla* — Periods of 19½, 20½, 20½, 21½ days noted. It is extremely surprising to us that the incubation time of this common sandpiper seems previously unreported.

Stilt Sandpiper, *Micropalama himantopus* — A minimum incubation period, 21 days, determined at a nest thought to have been found on day when last egg was laid. There is no previous report of an incubation period for this species.

Hudsonian Godwit, *Limosa haemastica.* — One period of 23½ days ± 5 hours. Ellis (1948. Northwood bound for godwits. Audubon Magazine 50: 154-159) reported an incubation period of approximately 22 days, but the eggs were not marked at this nest, and one disappeared early in incubation.

Northern Phalarope, *Lobipes lobatus* — One record, 22½ days.

Bonapart's Gull, *Larus philadelphia* — Not previously reported, the incubation period at one nest was 24 days.

Gray-cheeked Thrush, *Hylocichla minima* — One period of 12 days.

Savannah Sparrow, *Passerculus sandwichensis* — Two periods, both 12 days.

Harris' Sparrow, *Zonotrichia querula* — Minimum incubation period for one nest 13½ days, computed from laying of fourth to hatching of third egg; the fourth egg did not hatch. This nest was shown to us by R. Kontak.

Common Redpoll, *Acanthis flammea* — One record, 13 days.

Lapland Longspur, *Calcarius lapponicus* — Two incubation periods, both 13 days, recorded. Two other clutches incubated at least 13 days.

Smith's Longspur, *Calcarius pictus* — Previously unknown, the periods at three nests were 11½, 11½, and 12 days.

JOSEPH R. JEHL, JR.
D. J. T. HUSSELL

University of Michigan Museum of Zoology
Ann Arbor, Michigan,
1 November 1965

Sighting of a Hudsonian Godwit (*Limosa haemastica*) near Vancouver, B.C.

THE bird was first seen on the afternoon of September 13, 1964. It was standing at the water's edge, at half tide, on a muddy salt-water beach near the Vancouver city sewage plant at Iona Island, B.C. It was with a group of 20 Greater Yellowlegs (*Totanus melanoleucus*) and 5 Lesser Yellowlegs (*Totanus flavipes*), and was immediately seen to be a godwit by its bill (upturned, black with a light buff colour at the base) and its relative size.

My wife and I approached to within 100 feet of the bird, and viewed it with a 25x telescope. The white rump, and the broad black tail band with its white-tipped feathers were all clearly seen as the bird preened. A Pigeon Hawk put it up and the godwit showed its striking wing plumage well: the black axillars, generally dark under plumage, and the white stripe on the upper surface were all easily recognizable. A white superciliary line was noted; the legs were steel grey. The bird was in fall plumage: it was uniform grey (including the wings) shaded darker above and on the wings

than underneath. No call was heard. The bird did not feed.

On the following day, in the early evening, the bird was again observed by Mr. and Mrs. W. H. Hesse, of Vancouver. It allowed them to view it at leisure from a distance of about 15 feet. They both corroborated our identification.

The only records of this species for British Columbia given by the A.O.U. Check-list (fifth edition, 1957) are from the north of the province: "Casual in . . . British Columbia (Cariboo District, Peace River Parklands, Atlin) . . ." This apparently is the first record for the species in southwestern British Columbia.

FRED W. DOBSON

Institute of Oceanography
University of British Columbia
Vancouver, Canada
19 December 1964

Mass Movements by Snowshoe Rabbits, *Lepus americanus*

DURING the night of 27-28 March 1963, a mass movement of snowshoe rabbits occurred about 5 miles southwest of Kobuk village in northwestern Alaska. Tracks of an estimated 800-1000 animals were found which indicated a northwesterly movement over a front of about 2 miles within the white spruce (*Picea glauca*) — willow (*Salix* sp.) community bordering the Kobuk river.

A tenuous investigation has revealed evidence of only two similar events. Curiously, one of these occurred on the night following that of the Kobuk river movement. Hufman (personal communication, 1963) reported that a group of from 100 to 150 snowshoe rabbits travelled in a westerly direction over Paxson Lake in central Alaska on the night of 28-29 March 1963. The other event was observed near and on Red Lake, Minnesota on 1 March 1912 (Cox, 1936, Journal of Mammalogy 17: 216-221). Cox came upon the tracks of many snowshoe rabbits, all of which pointed in a northwesterly direction. Cox overtook the travelling animals and estimated their density as 20-50 per acre.

Climatological records show that weather sequences for the periods of the movements were remarkably similar in each case (U.S. Department of Commerce, 1963, Climatological Data, Alaska, 49: 34-47 and U.S. Department of Agriculture, 1912, Cooperative Observers Meteorological Records, Northern Minnesota). Nine days prior to each instance of mass movement the weather in northern Minnesota, central and northwestern Alaska was fine and calm with temperatures in the order of 0°F. There followed several days of rising temperatures and increasing air movement, culminating in temperatures about 32°F., precipitating snow and winds of about 35 m.p.h. Two days prior to the events the weather became calm with temperatures falling to between -10 and -20°F. at the time of each movement.

I recorded the mass movement of snowshoe rabbits in northwestern Alaska toward the end of my second winter of field studies of caribou (*Rangifer tarandus arcticus*) ecology. The subjective impressions that I gained of snowshoe rabbit behaviour during these winters support the possible existence of an association between activity and weather patterns. As was the case with caribou (Henshaw, 1964, University Microfilms, Ann Arbor, publication: M-746, 154 pp.), there appeared to be very little movement of snowshoe rabbits during periods of stormy weather, especially when snow was precipitating and the surface was being hardened by winds. Movement and feeding of snowshoe rabbits (as well as of caribou) were particularly in evidence during the calm, cold periods that followed storms.

JOHN HENSHAW

Box 593
College, Alaska, 99701
31 December 1965

Breeding Records of the Ring-necked Duck (*Aythya collaris*) in Rivière-du-Loup and Rimouski Counties, Quebec

PRELIMINARY investigations on waterfowl populations on inland waters on the south shore of the St. Lawrence Estuary have revealed the presence of a previously unreported population of breeding Ring-necked Ducks (*Aythya collaris*). As the breeding distribution of this species in Quebec is not well known (*see*: Mendall, Howard L. 1958. The ring-necked duck in the Northeast. University of Maine Bulletin 60 (16): 317 p.), I felt it worthwhile to publish these notes. These investigations were carried out mainly in Rimouski County although a few areas in Rivière-du-Loup County also were covered.

In 1964 several brood counts were conducted in this area. Despite the low intensity of these searches, five Ring-necked Duck broods were located, four in Rimouski County and one in Rivière-du-Loup County. In 1965 brood counts were not made but on June 20 a nest containing seven eggs was found (Rimouski County). An eighth egg was added, presumably the following day, but the nest was abandoned several days later. During the course of investigations many pairs of Ring-necked Ducks, whose behaviour suggested breeding, were observed.

Our observations suggest that this species is the third most common breeding duck on the inland waters of these counties. Only the Black Duck (*Anas rubripes*) and the Common Goldeneye (*Bucephala clangula*), in that order, surpass it in numbers.

AUSTIN REED

Quebec Wildlife Service
Parliament Buildings
Quebec, P.Q.
13 January 1966

Record of *Utricularia purpurea* in Newfoundland

THE writer wishes to report the finding on August 11, 1965, of several specimens of *Utricularia purpurea* Walt. near Colinet in the Avalon Peninsula of Newfoundland. The plants, in sterile condition, were growing in a large pond (47° 16′ 00″ N., 53° 32′ 20″ W.) three miles north of Colinet on Route 22, amongst a dense growth of the two other bladderworts, *U. vulgaris* L. and *U. intermedia* Hayne.

Specimens bearing collection number 320(c) are deposited in the herbarium of Memorial University of Newfoundland in St. John's and in the Marie-Victorin Herbarium of l'Institut Botanique de l'Université de Montréal.

This is the first record of *U. purpurea* in Newfoundland, and extends the known range beyond Nova Scotia and New Brunswick.

The writer thanks Dr. Ernest Rouleau, Curator of the Marie-Victorin Herbarium, for his advice, and for confirmation of the identification.

HILDA E. SMITH

Biology Department
Memorial University of Newfoundland
St. John's
4 January 1966

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STATUS OF THE WOOD IBIS, THE FULVOUS TREE DUCK AND THE WHEATEAR IN ONTARIO

JON C. BARLOW
Royal Ontario Museum, University of Toronto, Toronto, Ontario

SPECIMENS of the Wood Ibis, *Mycteria americana*, the Fulvous Tree Duck, *Dendrocygna bicolor*, and the Wheatear, *Oenanthe oenanthe*, recently obtained in Ontario make necessary a re-evaluation of the status of these birds in the Province. Extant records of the occurrence of each suggest that these species are better regarded as rare, but irregular, non-breeding visitants rather than as vagrants in Ontario. The new specimens, reported herein, are housed in the collection of the Department of Ornithology of the Royal Ontario Museum. The distribution of the known records in the Province is shown on the accompanying map (Figure 1).

The dessicated carcass of a Wood Ibis (ROM 95204, saved as a skeleton) recently donated to the Museum constitutes the second preserved specimen of this species for Ontario. The bird was found by Dr. Keith Quirk on August 4, 1965, at (1) Dorcas Bay, Bruce County. The other extant specimen (ROM 76069) was taken on August 2, 1948, at (2) Apple Hill in Charlottenburgh Township, Glengarry County, by A. Strang (Snyder, 1949).

Four other records of varying credibility are as follows: a bird sketched in death, but not subsequently saved, shot near (3) Simcoe, Norfolk County, in November of 1892 (Fleming, 1913); some time prior to 1912, probably in August, an individual, first wounded near Port Huron, Michigan, then seen to fly across the St. Clair River into adjacent Ontario, (4) near Sarnia, Lambton County (Barrows, 1912); one observed by Dr. W. E. Hurlburt on November 9, 1950, near (5) Hamilton, Wentworth County (Baillie, 1951); and a single individual observed between September 1 and September 12, 1954, at (6) Old Squaw Point, Cataraqui Creek, near Kingston, Frontenac County (Quilliam and Stewart, 1954).

The age and sex of none of these birds is known with certainty. However, wing (461 mm.) and bill (from fronto-nasal hinge, 236 mm.) measurements of the present specimen are comparable to those of (adult) males in the Museum collection. Likewise on the basis of the nakedness of the crown and upper neck our bird is thought to be an adult. A photograph of the other extant Ontario specimen (now preserved as a skeleton) shows that it was a juvenile, as the upper parts of the neck and the crown were feathered. Thus it appears that the northward post-breeding dispersal characteristic of this species involves both juveniles and adults.

Mailing date of this number: 19th January, 1967

A mounted specimen of a Fulvous Tree Duck (ROM 95559), presented to the Museum through W. H. Carrick, proves to be the first individual of this species from Ontario. The bird was shot on December 8, 1960, by L. E. Roberts at (7) the Big Point Club, south of Mitchell's Bay, Lake St. Clair, Kent County. In addition ROM 95559 is the first known individual to be taken in eastern Canada, predating specimens taken in November of 1961 in New Brunswick (Squires, 1962) and constitutes the second record from the entire country, the first being a mounted bird in the provincial museum at Victoria, British Columbia — one of five birds shot from a flock of 11 seen near New Alberni, Vancouver Island, in September of 1905 (Macoun and Macoun, 1909). Thus a specimen (ROM 93291) secured on November 27, 1962, one of three seen at (8) Frenchman's Bay, Ontario County, and previously reported as the first specimen from Ontario (Woodford, 1963; Baillie, 1964) is in fact the second one. Additional records from Ontario include: two birds photographed at (9) Yacht Harbour, Welland County, on August 20, 1962; and one seen regularly between April 7 and early May, 1963 at (10) Fanshawe Lake, Middlesex County (Baillie, 1964).

The Lake St. Clair specimen was apparently the harbinger of the conspicuous influx into eastern and east-central Canada and adjacent parts of the United States, first noted in New Brunswick (Squires, 1962) and subsequently in Ontario (Baillie, 1964) and neighboring Michigan (Hunt, 1963). Baird (1963), discussing the northward spread of this species had suggested that the birds found in the Great Lakes region in 1962 reached there either by flying from the Gulf coast up the Mississippi River and then along one of its tributaries or they may have headed inland from the east coast build-up which had been detected as early as 1955. Our specimen indicates that inland movement from one of the above sources was underway as early as 1960.

A female Wheatear (ROM 95565) was obtained on September 28, 1965, by Dr. A. E. Allin at (11) Fort William, Thunder Bay District, as it foraged alone near the shore of Thunder Bay on Lake Superior. This specimen had a completely ossified skull, only a light accumulation of fat, weighed 39 grams, and measured as follows: wing (chord), 106.6 mm.; tail, 57.1 mm.; tarsus, 28.1 mm.; bill (from the anterior edge of the external nares), 9.4 mm. On the basis of comparison with available Museum material the new specimen is referable to the Greenland race, *O. oenanthe leucorhoa.*

The above-mentioned is the fourth Wheatear collected in Ontario and the first from the Province housed in a Canadian museum. Other records from the Province include: an adult male shot along (12) the Albany River, Kenora District — probably near Martin's Falls (Baillie, MS) — prior to 1840 by George Barnston (Seebohm, 1881) now in the British Museum (Nat. Hist.); one (sex unknown) taken at (13) Chatham, Kent County, in 1889 by J. A. Jermyn (W. E. Saunders, unpublished field notes for 1901) — the whereabouts of this specimen is at present unknown; a male shot at (14) Beaumaris, Lake Muskoka, Muskoka District, on September 25, 1894, by P. A. Taverner (in Webb, 1895) — number 135063 in the collection of the United States National Museum (personal communication, L. L. Short to A. E. Allin); one seen by Dr. D. Derry (ROM unpublished field notes) on (15) the Ontario side of Island Lake,

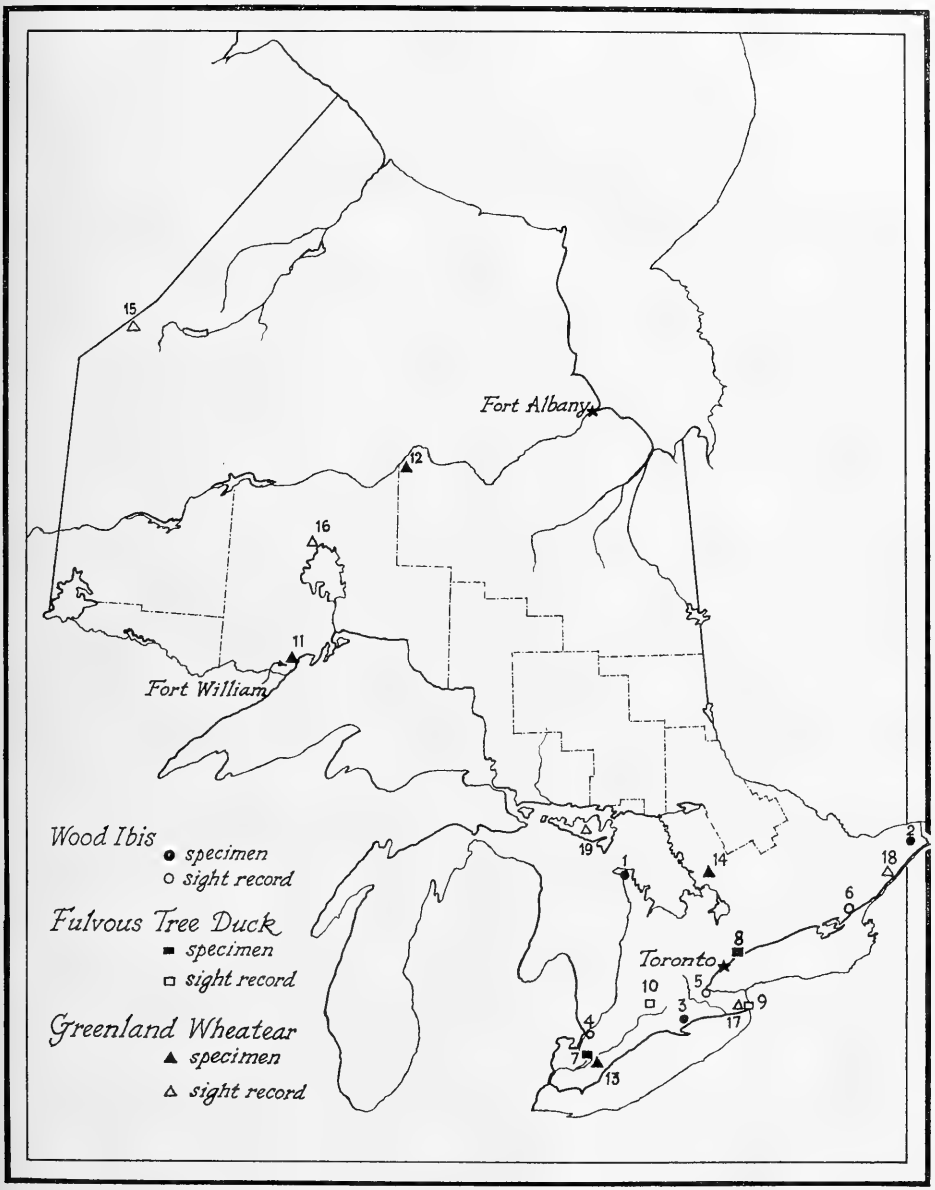

FIGURE 1. Records of the Wood Ibis, the Fulvous Tree Duck and the Wheatear in Ontario. Numbers refer to localities mentioned in the text.

West Kenora District, in the autumn of 1930; one seen at (16) Ferland, 25 miles west of Ombabika, Thunder Bay District on June 6, 1941 (personal communication, G. A. Scott to J. L. Baillie); one seen (17) 2 miles west of Ridgeway, Welland County on September 24, 1949 (Wright, 1950); one seen at (18) Hainsville, Dundas County on September 25, 1952 (Baillie, 1953); and one seen at (19) Mindemoya, Manitoulin Island, Manitoulin District on September 25, 1963 (Goodwin, 1964).

With the exception of the June observation mentioned above all the records for which there are exact dates, are from early autumn and suggest that the Ontario birds are fall migrants displaced from their traditional trans-Atlantic and western European route. In fact the late September dates, most prevalent for the discovery of the Wheatear in Ontario, roughly correspond to dates of normal migration in the British Isles (Witherby, *et al.*, 1940).

Acknowledgments

Mr. James L. Baillie, Dr. R. L. Peterson, and Dr. G. B. Wiggins gave consultation during preparation of the manuscript. Dr. A. E. Allin supplied additional information on specimens of the Wheatear and Mr. Paul Geraghty prepared the map.

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WHAT ARE THE BLUE BIRCHES?

T. C. Brayshaw

Department of Forestry of Canada, Petawawa Forest Experiment Station,
Chalk River, Ontario*

Review of Literature

There has long been a divergence of opinion among botanists regarding the identity and actual status of the eastern North American trees known as the blue birch and the big blue birch (or blueleaf birch).

W. H. Blanchard, writing in *Betula*, Volume one, Number one (May 7, 1904), described two newly discovered species of birch, which he called the blue birch (*Betula caerulea*) and the large blue birch (*B. caerulea-grandis*). He described the leaves of both as having long slender petioles, as being bluish, long-pointed, thin, somewhat cuneate at base, glabrous on both sides, and usually with no tufts of tomentum. The bark is separable into sheets. *B. caerulea* was distinguished as being a small tree, though larger than the grey birch (*B. populifolia* Marsh.), with its leaves somewhat cuneate at base, and strobiles, or catkins, cylindric, and one inch by three eighths. *B. caerulea-grandis* was distinguished from the other species by its large size, being fully as large as the canoe or white birch (*B. papyrifera* Marsh.), with larger and often nearly truncate leaves, and much larger fruiting catkins. For both species, Blanchard mentioned that the fruiting bracts were very distinctive in shape, but in neither case did he describe them.

In Volume one, Number two (May 13, 1904) of *Betula*, Blanchard wrote a second paper entitled: "A New White Birch". In this paper the two birches were named respectively, *Betula caerulea* and *B. caerulea* variety *grandis*. Both the title and the inserted word "variety" indicate that he had by then had second thoughts about the identity of the large blue birch, and was recognizing only one species. However, in one copy of this paper, in the possession of the Gray Herbarium of Harvard University, he had added a handwritten note at the end: "I believe these are two good species", suggesting a return to his original opinion. He said he had found these species at Stratton and Windham, Vermont.

Sargent at first (1905: p. 202) accepted *B. caerulea*, but renamed the large blue birch, variety *Blanchardii* (of *B. caerulea*). In 1922 (pp. 211-212), however, he indicated that he suspected both these forms had originated as hybrids between *B. papyrifera* and *B. populifolia*.

Fernald (1922) believed that *B. caerulea-grandis* was a good species, and *B. caerulea* a hybrid between it and *B. populifolia*.

Woodworth (1929) agreed with Fernald's interpretation, considering Sargent's to be impossible, because in counting chromosomes in specimen trees growing in the Arnold Arboretum, he found the following haploid values:

*Present address: 601, 1049 Chilco Street, Vancouver 5, British Columbia.

B. caerulea	14	
B. caerulea-grandis	14	
B. populifolia	14	
B. papyrifera	35	'meiosis almost normal'
B. papyrifera var. *cordifolia*	28	'meiosis slightly abnormal'

In more recent work on the genetics of *Betula,* Johnsson (1949) described a number of experimental crosses between several species, including a *B. papyrifera* with a diploid chromosome count of 84, but no other North American species. He counted the chromosomes in large samples of seedlings grown from seed of wild trees, and found that the commonest diploid value for *B. papyrifera* was 84, but he also found nearly all values between the figure and 70. He crossed the 84-chromosome *B. papyrifera* with two European species, *B. verrucosa* with 28 chromosomes, and *B. pubescens* with 56. Despite the differences in chromosome number, he obtained hybrid offspring from both crosses. The *B. papyrifera* X *verrucosa* hybrids showed generally normal meiosis and produced many viable seeds; while the *B. papyrifera* X *pubescens* hybrids had very abnormal meiosis and produced very few viable seeds.

In this genus, difference in chromosome numbers between species is evidently not by itself a fully effective barrier to crossing. Hybrids between species with different chromosome numbers could be expected to possess intermediate chromosome numbers, and this is what Johnsson found for the first generation hybrids. The incidence of irregularities at meiosis may lead to later generations that show various numbers not necessarily representing integral genomes. That such individuals may survive is shown by the variety of chromosome numbers in the wild *B. papyrifera.* This species may be interpreted as one with a normal somatic complement of 84 chromosomes but which due to introgression by other species of lower chromosome number has come to include in its overall population a proportion of individuals with chromosome numbers lower than the normal number but which nevertheless are at least partially fertile.

THE PROBLEM

Since their original descriptions were published, blue birches of one form or another, have been found at a number of places in the New England States, and in Quebec and the Maritime Provinces. It is noteworthy that the region over which they have been found coincides with the overlap in the ranges of the white and gray birches. Blue birch trees, however, are found in groups in scattered localities in this area, often on abandoned farmland or other sites of disturbance.

There is still uncertainty regarding the actual status and relationship of these birches. The blue birch and the large blue birch (or blueleaf birch, as it is also called in Canada) may be good species in their own right; they may be varieties of the white or grey birches; or they may constitute a hybrid swarm between the latter species as parents.

If they are distinct species, there should be clear-cut arrays of characteristics by which their populations can be distinguished from those of the white

and grey birches. If they are varieties of either of the other species, a less clear-cut array of distinguishing characteristics should in each case be associated with several characteristics shared with the species to which it belongs and with intermediate expressions of some characters bridging the gap between the variety and the species to which it belongs. There should also be clear distinctions between the expressions of some characters in each variety and the expressions of the same characters in the unrelated species. If the blue birches are a hybrid swarm between the white and grey birches, their populations can be expected to show diverse sharing of some of the characteristics that distinguish the parent species, with variously intermediate expressions of other specific characters.

The only characteristic mentioned in Blanchard's descriptions by which the blue birches differ from both the white and grey birches is the blue colour of the foliage. This feature is not preserved reliably in herbarium specimens, and living trees identified as blue birches that the author has seen have been little if any bluer in foliage than healthy specimens of white birch. It may be that the impression of colour gained by the eye is affected by some inherited difference in the lustre of the fresh leaf surface not preserved in dried material. In other described characteristics, the blue birches are either similar to white or grey birches, or intermediate between them.

EXAMINATION OF MATERIAL

To arrive at a more definite conclusion as to the true status of the blue birches, the author examined herbarium specimens at the Plant Research Institute and the National Museum in Ottawa, at the Petawawa Forest Experiment Station at Chalk River, Ontario, and in the Gray Herbarium of Harvard University at Cambridge, Massachusetts. Among the specimens seen at Harvard were several collected by Blanchard, including isotypes of his *B. caerulea* and *B. caerulea-grandis*. Specimens from six trees of the latter species grown at the Arnold Arboretum, Jamaica Plain, Massachusetts from seed provided by Blanchard, were also examined. In addition to the material of the blue birches, specimens of white birch and grey birch were examined, the white birch drawn from areas both within and without its area of overlap with grey birch. For the purpose of initial segregation of the specimens, the names as determined by their collectors were accepted. Living trees of these birches were sampled during a trip to the Maritime Provinces and Quebec in 1960.

A number of morphological differences between the species, and the distribution of characteristics among the species, were noted. For a variety of reasons, several characters of the living trees were unusable: e.g. growth habit, attitude of leaf and catkin, and colour and surface lustre of leaf, characters not preserved in herbarium specimens and seldom noted by collectors. Bark is seldom collected, and so was not used in this work. Foliage and fruit, however, provided several characters that could be compared; and of these, eight were sufficiently commonly represented and showed sufficiently clear distinctions between species, to be used in this investigation.

SYMBOL ARMS AND HYBRID INDEX SCORES

			SYMBOL ARM	HYBRID INDEX
LEAF	Attenuation Factor*a/m.	1.0 or less		0
		Between 1.0 & 1.7		1
		1.7 or more		2
BRACT	Length	More than 4.5 mm.		0
		4.0 – 4.5		1
		Less than 4.0		2
LEAF MARGIN		Not sinuate	•	0
		Slightly sinuate	←	1
		Strongly sinuate	←—	2
VEINS,	(beneath)	Pubescent	•	0
		Glabrous	↑	1
CATKIN	Length	28 mm. or more	•	0
		27 mm. or less	↗	1
BRACT	Lateral lobes	Ascending	•	0
		Spreading	→	1
		Reflexed	—→	2
BRACT	Terminal lobe	Oblong-lanceolate	•	0
		With flaring base	↓	1
SAMARA	Body surface	Pubescent	•	0
		Glabrous	↙	1
Ideal *B. populifolia:*		Scattergram symbol & Index score	✳	12

IDENTIFICATION of BLANCHARD'S Collections

B. caerulea-grandis

- Is Isotype
- T Marked 'TYPICAL'
- B Other Blanchard collections
- S Grown from seed provided by Blanchard

B. caerulea

- CI Isotype
- CB Other Blanchard collections
- C Other collections

Other collections not identified for this species

*Components of ATTENUATION FACTOR a/m

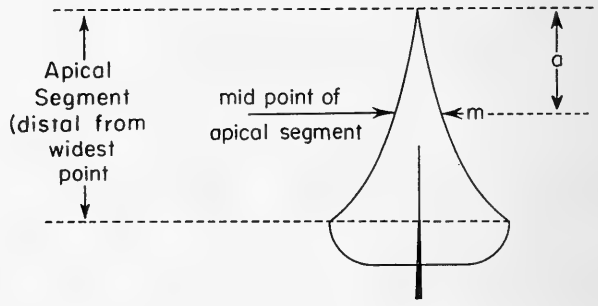

FIGURE 1. Key to the symbols for character expressions in the scatter diagram, the identity of significant specimens, and the allocation of hybrid index values.

Records of character expressions were made in a way that allowed them to be plotted in scatter diagrams modified after the manner of Anderson (1949). By assigning hybrid index values to the expressions, the total value for the

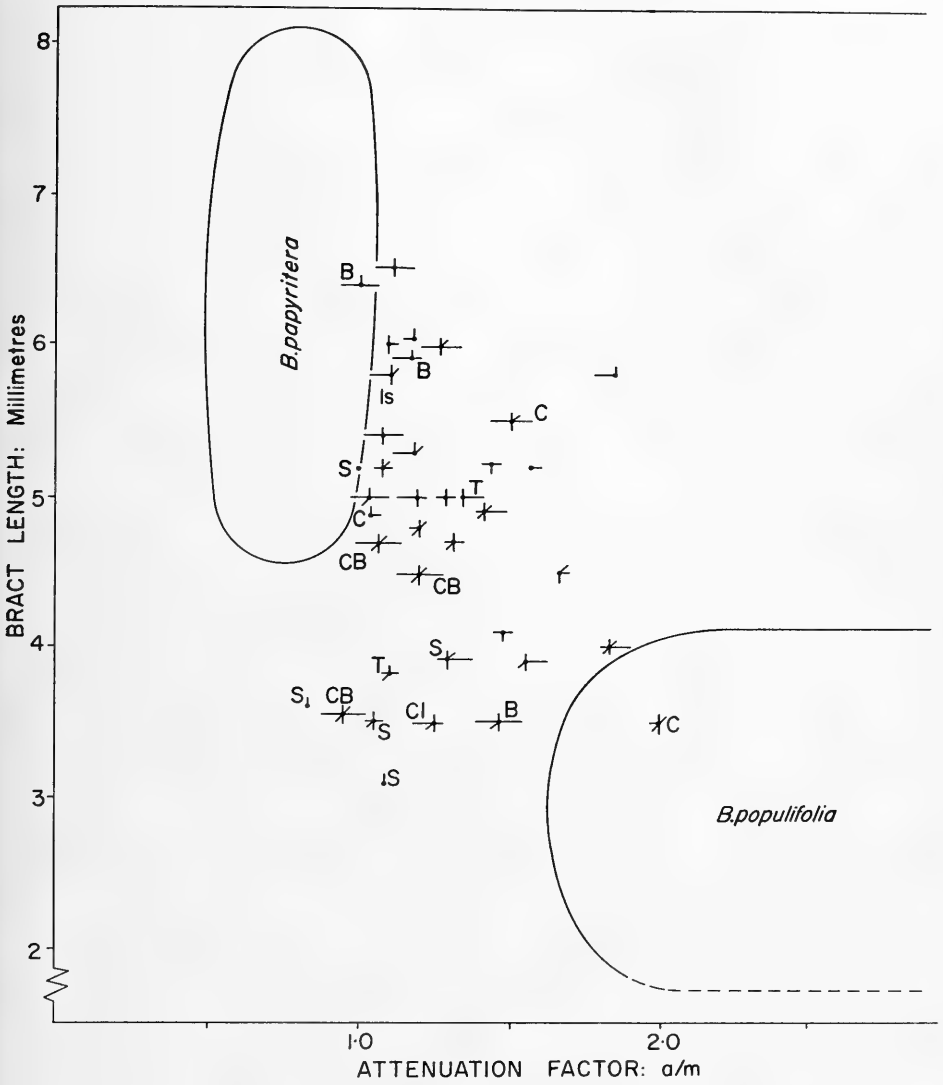

FIGURE 2. Modified scatter diagram of the populations of *Betula caerulea* and *B. caerulea-grandis*, showing their relation to those of *B. papyrifera* and *B. populifolia* (outlined).

expression of a species in each specimen could be summed (*ibid.*). As indicated in Figure 1, the ideal pure specimen of *B. papyrifera* should have an index value of 0 or 1 and the ideal pure specimen of *B. populifolia* should score 12. Deviations of up to two or three points from these ideals can be expected as an expression of the natural range of individual variation within either species. In the scatter diagram, a pure *B. papyrifera* specimen should be represented as an unappendaged spot in the upper left hand portion of the diagram, while

a pure *B. populifolia* specimen should appear as a star-like figure in the lower right hand corner. The areas occupied by these species are outlined in the scatter diagram (Figure 2).

RESULTS AND CONCLUSIONS

Examination of the symbols and their distribution on the scatter diagram reveals four interesting points:

(a) The area of the diagram occupied by the blue birch population completely bridges the gap between the white and grey birches.

(b) The range of leaf attenuation in the blue birches is relatively narrow, and for the majority of specimens lies between the ranges for the white and grey birches. This observation suggests that the specimens had been identified as blue birches by their collectors mainly on the basis of leaf shape.

(c) The range in bract length in the blue birches is relatively wide, overlapping considerably those of the other two species. This suggests that less attention has been paid to this character, no doubt in part at least as a result of the lack of description of the bracts in Blanchard's original publications.

(d) The distribution of other character expressions is extremely diverse, even among the specimens collected by Blanchard, a fact that adds weight to the suspicion stated in (b) above.

It can be seen in Figure 2 that various specimens of *B. caerulea-grandis* share various characteristics with either white or grey birch, or show intermediate expressions, with little apparent consistency, even when observation is confined to Blanchard's collections. It is possible to find several pairs of specimens that, apart from their positions in the diagram, possess none of the distinguishing characteristics of any other species in common. Only a few usable specimens specifically identified by their collectors as *B. caerulea* were seen. Compared with those marked *B. caerulea-grandis*, they appear, on the average, to be a little more consistent with the description, and to resemble grey birch more, as shown by their index values (Table 1). Even so, there is enough diversity among them to suggest that if *B. caerulea* is regarded as a good species, it must have suffered much introgression from the others.

The hybrid index summarizes the score of the character expressions for each specimen (Table 1). A comparison between the distributions of index values of the two white birch populations reveals a significant fact. The spread of the scores in the population of those specimens from beyond the range of grey birch is narrow and concentrated at the lowest values, 27 of the 36 specimens examined having a score of 0 or 1, the mean being 0.9. On the other hand, the range for white birch specimens from within the range of grey birch is much wider, extending to 7, more than half way along the scale toward the grey birch end, with a mean of 2.5. Scatter diagrams of these populations (not presented here) show that they have practically the same range of leaf attenuation values, but specimens from within the range of grey birch tend on the average to have rather shorter bracts. Diverse occurrences of other grey birch characteristics account for the frequently higher index values and the higher mean in the latter group. This observation again suggests the strong

TABLE 1. — Distributions of hybrid index values in the populations examined

Populations	Hybrid Index Values													
	0	1	2	3	4	5	6	7	8	9	10	11	12	Mean
Betula papyrifera														
beyond range of *B. populifolia*	14	13	4	3	2									0.9
within range of *B. populifolia*	2	9	9	4	1	1	1	1						2.5
B. caerulea-grandis														
Isotype							1							6.0
marked 'Typical' by Blanchard						1				1				7.0
other collections by Blanchard					1	1					1			6.3
grown from Blanchard's seeds	1			1	1				1	1				4.8
other collections				2	2	5	4	4	2	1	1			6.0
Total (*B. caerulea-grandis*)	1			3	4	7	5	4	3	3	2			5.9
B. caerulea														
Isotype										1				9.0
other Blanchard collections									1	1	1			9.0
other collections				1			1			1				6.0
Total (*B. caerulea*)				1			1		1	3	1			7.7
B. populifolia								1	1	1	7	12	21	11.1

influence of leaf shape on the identification of a specimen by its collector. The difference in range of index values between these two populations, and the diversification of characteristics of those associated with the grey birch indicate that introgression of white birch by grey or blue birches has occurred. These birches are apparently interfertile, despite differences in chromosome number.

Of the three possible explanations of the status of the blue birches mentioned above, the only one that fits the observed distribution of characteristics is the third: that the blue birches constitute a hybrid swarm between the white and grey birches. A natural hybrid between the white and grey birches could be expected to show characteristics that would lead to its being called a blue birch or a large blue birch if its hybrid origin were not suspected. If the hybrid enjoyed even a moderate degree of fertility, and crossing among hybrids or backcrossing to the parent stocks continued through further generations, the result would be a population with diverse combinations of parental characteristics, and intermediate forms of expression of those characters determined by multiple genes, as leaf shape appears to be. This situation is just what has been found in this appraisal of the blue birches.

It appears that the blue birches, in their diverse forms, are morphologically indistinguishable from a hybrid swarm between white and grey birches. Sargent's (1922) suspicion thus seems to have been justified. Actual breeding experiments and more cytological work, however are still needed to test this interpretation more stringently.

The very spotty distribution of the blue birches suggests that they have originated separately at a number of places. This may occur where disturbance creates new habitats differing from those to which the parent species are naturally adapted, and in which hybrid seedlings may become established free from competition by established parent populations. Such habitats favourable for seedling establishment are found in pastures, cleared roadsides, clearings persisting on abandoned farms, and other sites of human activity.

The disjointed distribution of the blue birches, and their recent discovery in a region with a long history of botanical exploration suggests that this swarm has arisen in response to human disturbance of the natural habitats of the parent species, and that it may be of quite recent origin historically.

According to the rules of botanical nomenclature, all hybrids of like parentage should be designated by the same name. In this instance, of the two names given by Blanchard, the choice falls on *B. caerulea*, since it was the first mentioned by him, and was applied by him to the entity of which he evidently had the more consistent opinion regarding its distinctness from other birches. Members of this hybrid swarm are thus designated as *Betula* X *caerulea* Blanchard (pro sp.).

SUMMARY

Herbarium specimens of the blue birch (*Betula caerulea* Blanchard) and the big blue birch (*B. caerulea-grandis* Blanchard), including material collected by Blanchard, are examined. This material is compared with specimens of grey birch (*B. populifolia* Marsh.) and two populations of white birch (*B. papyrifera* Marsh.). From the diverse ways in which the distinctive character-expressions of the white and grey birches are distributed among the specimens of the blue birches, it is concluded that the latter constitute a hybrid swarm between the white and grey birches, as was originally suspected by Sargent.

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A WET PRAIRIE COMMUNITY AT WINDSOR, ONTARIO[1]

C. M. Rogers
Department of Biology, Wayne State University, Detroit, Michigan

On the southern outskirts of Windsor, Essex County, Ontario, there has developed a plant community which most closely resembles Curtis' description (J. T. Curtis, 1959) of a wet prairie or wet-mesic prairie. It is, however, surrounded by deciduous forest, and some of the area itself would be better described as open woodland, savanna or oak opening (Figure 1). Though most of the species found there grow in other parts of southern Canada, the total assemblage of plants is sufficiently distinctive to warrant a brief note of its existence. The fact that the expanding city will surely shortly obliterate it also makes it seem worthwhile to describe this community now.

The location and extent of the community is shown on the accompanying map (Figure 2). It occupies about two square miles; its boundary coincides fairly closely with that of the Granby Sand soil type.

The exact history of the area is not known, but it is probable that at various times forest trees were more prevalent than now. The retreat of the glacier and the post-glacial xerothermic period doubtless provided the opportunity for plants with predominantly more southerly ranges to immigrate to this general area. Though the present climate favors the development of a deciduous forest, it is likely that disturbance through the years has favored the invasion and persistence of herbaceous species characteristic of the prairie community. Certainly, the early burning of the vegetation by the Indians and the clearing and more or less regular burning by white settlers have contributed to the establishment of many of the perennial herbs of the wet prairie. Curtis points out that in Wisconsin such prairies as these are fire-controlled, and it is apparent here that if the land were left undisturbed, it would in time return to a forest community. Some land is currently under cultivation; other parts have not been tilled within the memory of the present inhabitants. Cultivation by white man was probably never sufficiently intense to destroy this herbaceous vegetation but no doubt helped prevent the full development of the forest.

The high water table and slow run-off, producing very wet conditions in the spring, contribute to the selection against certain kinds of trees and favors the more shallowly rooted herbs. Partial draining of the area during the last 35 to 40 years has no doubt changed the densities of many of the species and aided in the invasion of shrubs which are becoming established. Though the area is generally level, it has been found that slight variations in topography have considerable effect upon the local distribution of plants.

[1]Contribution No. 157 from the Department of Biology, Wayne State University, Detroit, Michigan.

FIGURE 1. A portion of the wet prairie area showing *Spartina pectinata* with scattered individuals of *Quercus*.

Certainly the type of soil must be significant in the development of this kind of plant community, since the other factors described above appear to apply equally well to all of the adjoining lands.

In summary, therefore, it appears that post-glacial xerothermic conditions, high water table and soil type, combined with man's activities, particularly intermittent burning and tilling, have provided a combination of factors which have allowed the establishment of a comparatively large number of species which have ranges extending southward and westward, and which in their aggregate, may be considered a type of wet prairie.

Because of the effect of slight elevation differences and the erratic patterns of burning, farming, and partial draining, there are no species which can be described as dominants over the whole area. In parts, trees, principally *Quercus velutina* and *Q. borealis*, provide an upper story, while, in the more open areas, *Q. palustris* and colonies of *Cornus racemosa* and *Corylus americana* are conspicuous. In addition there are found occasional individuals of *Acer*

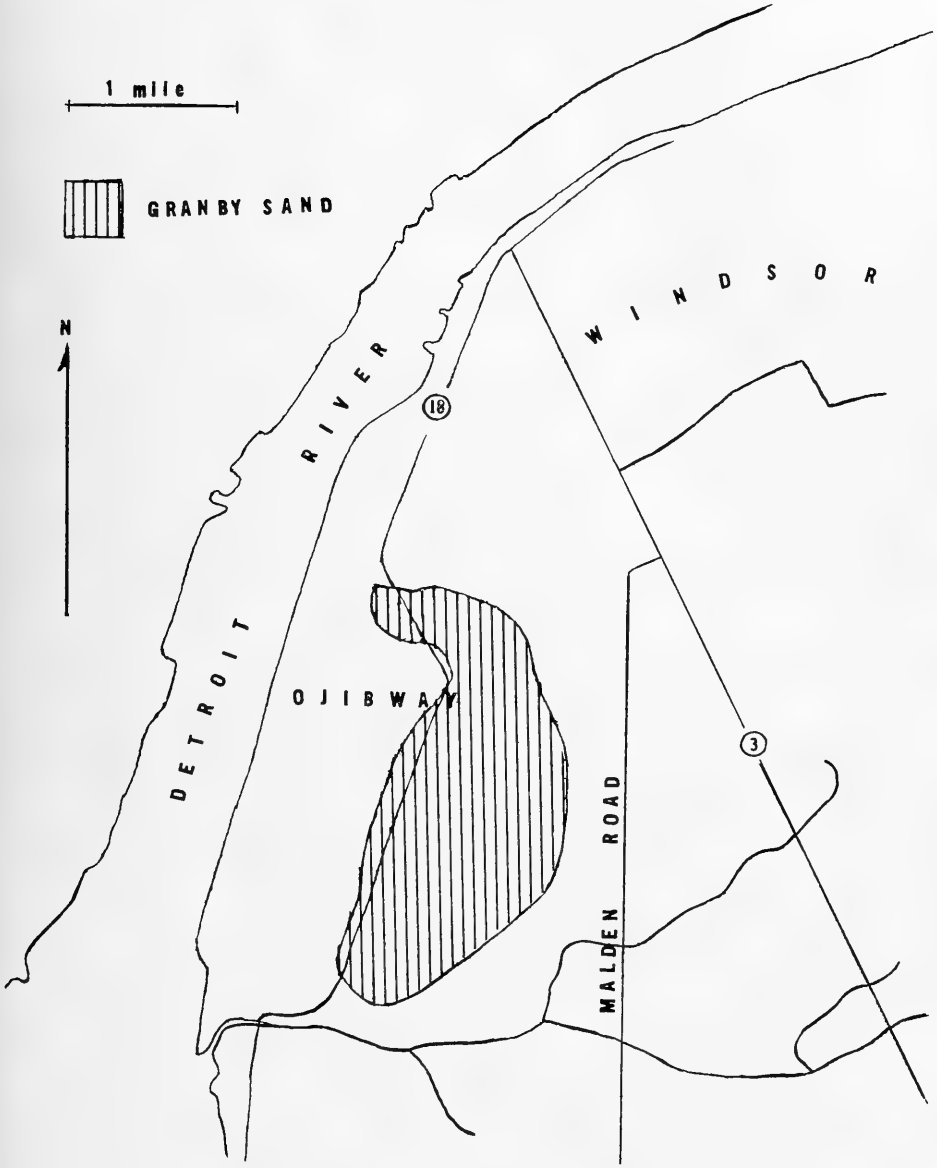

FIGURE 2. Location and extent of the Grandby Sand soil type which corresponds approximately with those of the prairie community.

rubrum, *Ulmus americana*, *Prunus serotina*, *Quercus bicolor*, and *Fraxinus americana* which are characteristic of the more or less undisturbed forest. Weedy species such as *Crataegus* spp; *Populus* spp. and *Rhus* spp. also contribute to the woody vegetation. Over much of the moist portion the grasses

Calamagrostis canadensis and *Spartina pectinata* are common species. *Andropogon gerardi*, *Panicum virgatum*, and *Sorghastrum nutans*, prevalent grasses in the tall-grass prairie, may all be found here, though none are common. In quadrat studies the following herbs were found to be best represented: *Baptisia tinctoria*, *Solidago canadensis*, *S. graminifolia*, *Aster ericoides*, *A. azureus*, *A. laevis*, *Desmodium canadense*, *Pycnanthemum virginianum*, *Fragaria virginiana*, *Liatris spicata*, *Rubus villosus*, *Panicum* spp., *Amphicarpa bracteata*, *Carex* spp., *Pteridium aquilinum*, *Viola sagittata*, and *Achillea millefolium*.

Nearly 300 species of vascular plants have been collected from the area. A number of them are cosmopolitan weeds, in excessively disturbed places; others are clearly dependent upon the woody upper story and are not of particular significance insofar as the prairie community is concerned.

Because of their relative abundance or their apparent affinity for this type of plant community, the following species may be considered representative. Species prevalent or reaching their greatest abundance in wet prairies or wet-mesic prairies *fide* Curtis are indicated by an asterisk. Specimens of each species are in the herbarium of Wayne State University.

*Equisetum arvense**
*Dryopteris thelypteris**
Pteridium aquilinum
Puccinellia distans
*Calamagrostis canadensis**
Sporobolus cryptandrus
*Spartina pectinata**
*Hierochloe odorata**
Panicum spp.
Panicum virgatum
*Andropogon gerardi**
*Andropogon scoparius**
*Sorghastrum nutans**
Carex spp.
*Scleria triglomerata**
*Tradescantia ohiensis**
Juncus torreyi
Lilium michiganense
Aletris farinosa
*Hypoxis hirsuta**
*Salix humilis**
*Comandra richardsiana**
Polygonum tenue
Atriplex patula
*Thalictrum dasycarpum**
Anemone cylindrica
*A. canadensis**
*Spiraea alba**
S. tomentosa
Rubus villosa
Pyrus coronaria
*Fragaria virginiana**
Baptisia tinctoria
*Desmodium canadense**
*Lespedeza capitata**
Apios americana
Strophostyles helveola
Amphicarpa bracteata
*Lathyrus palustris**
Linum medium
Polygala sanguinea
P. verticillata
Euphorbia dentata
*E. corollata**
E. vermiculata
Hypericum gentianoides
H. majus
Helianthemum canadense
H. bicknellii
Lechea villosa
Viola sagittata
*Lythrum alatum**
Gaura biennis
Taenidia integerrima
*Oxypolis rigidior**
Lysimachia quadriflora
L. thyrsiflora
*Gentiana crinita**
*G. andrewsii**
Apocynum androsaemifolium
*A. cannabinum**
Asclepias tuberosa
*A. syriaca**
A. sullivantii
A. viridiflora
*Phlox pilosa**
*Lithospermum canescens**
Verbena simplex
V. stricta
Lycopus virginicus

*Pycnanthemum virginianum**
Teucrium occidentale
Stachys palustris
*Monarda fistulosa**
Solanum carolinense
Mimulus ringens
*Veronicastrum virginicum**
Penstemon hirsutus
Gerardia purpurea
G. tenuifolia
G. flava
*Pedicularis lanceolata**
*Galium tinctorium**
*Lobelia spicata**
Liatris spicata
*Eupatorium maculatum**
Solidago canadensis
*S. graminifolia**
*S. rigida**
S. riddellii
S. bicolor
*Aster ericoides**
*A. azureus**
*A. laevis**
A. subulatus
*A. novae-angliae**
A. umbellatus
*Erigeron strigosus**
*Achillea millefolium**
*Silphium terebinthinaceum**
*Ratibida pinnata**
*Rudbeckia hirta**
Coreopsis tripteris
*Helenium autumnale**
Krigia biflora
*Prenanthes racemosa**

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BENTHOS OF FOUR LAKE SUPERIOR BAYS

M. L. H. Thomas
Fisheries Research Board of Canada, Biological Sub-Station, Ellerslie, P.E.I.

Introduction

Explorations for larval lamprey in four bays in Canadian Lake Superior during 1959 to 1961 produced large collections of benthos and bottom living fishes. Benthic fauna of this area is little known and therefore every effort was made to identify that which was collected. This information is presented below.

The location of the four bays sampled is shown in Figure 1.

Methods and Equipment

Sampling along shores in water to 1 m deep was carried out using an A.C. electro-fishing technique similar to that described by Tibbles (1959). This method caused larval lamprey to leave their burrows, to die and to be collected with other fish in the water. Other fauna was collected with a net. The method was efficient for the collection of fish and epi-fauna; although infaunal animals were missed.

Deep water collecting was mostly done with a modified anchor dredge (Thomas, 1960). This is an efficient qualitative sampler of fossorial and surface-living benthos and also takes many active animals such as fish and crayfish. But it does not retain fauna smaller than 3 mm. Some sampling at 2 to 10 m depth was carried out using rotenone poison in 0.9 m square, 20 cm deep metal trays set opening-down on the bottom. Poison was applied through a port and left for 24 hours. The fauna killed was collected by S.C.U.B.A. equipped divers.

Survey Locations

The four bays explored are widely separated as shown in Figure 1 and present diverse habitats.

The most easterly locations, Goulais Bay and Batchawana Bay, are generally similar. Batchawana Bay was the site of the most intensive collecting. The two bays are relatively shallow bodies of water, much of their area lying in less than 6 m of water, with extensive sand flats off river mouths averaging about 3 m. The deepest sounding in Batchawana Bay is 40 m. Bottom deposits in deep water are mainly mud. Prevailing south-west winds accumulate warm surface water in the bays and normal summer water temperatures range from 18°-22°C. Both bays are productive and support some commercial and extensive sport fisheries.

Mountain Bay is part of Nipigon Bay, a large shallow bay forming the northernmost part of Lake Superior. Most of Mountain Bay lies in about 18 m of water with bottoms of mixed clay, mud and fine sand but there are extensive sand flats off river mouths. The bay is warm in summer attaining temperatures similar to Batchawana Bay.

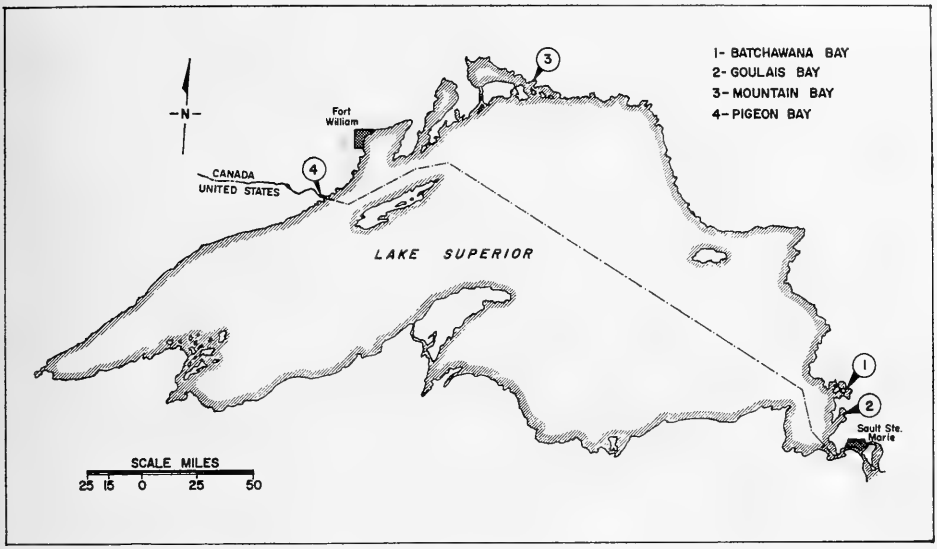

FIGURE 1. Lake Superior showing the location of the four bays in which collections were made.

Pigeon Bay at the Canadian-United States border at the west end of Lake Superior is cold, deep and narrow. Much of the bay is over 30 m deep but sampling was mainly confined to shallower parts. Water temperatures are low, only the upper few meters ever rising above 10°C. Bottom deposits are mainly soft brown mud but granite outcroppings occur.

THE FAUNA COLLECTED

Most of the fauna collected was identified. Table 1 lists all species or groups determined and shows the number of stations in each general locality at which they were taken. Where the total number of specimens of each species for each locality was recorded this is also presented. As sampling was not quantitative numbers indicate only relative abundance. Complete details of sampling stations and specimens collected are reported elsewhere (Thomas, 1965).

Table 1 is self-explanatory; the following notes are limited to ecological information and special situations.

ANNELIDA : HIRUDINEA

Among the annelids only the Hirudinea have been identified; oligochaetes were frequent in many of the collections.

Distribution of some leeches was correlated with depth. All species were most common in relatively shallow water, none being taken at deeper than 30 m. *Erpobdella punctata* was taken only in shore collections in the eastern bays. *Haemopis grandis* was not found in over 9 m, and most frequently taken

TABLE 1.—Benthic species collected in four Lake Superior Bays
Number of stations at which each species was collected in each area with total number of specimens (brackets).

Species or Group	Goulais Bay Shores	Batchawana Bay Shores	Batchawana Bay Off-shore	Mountain Bay Shores	Mountain Bay Off-shore	Pigeon Bay Off-shore
	26 Sta.	98 Sta.	113 Sta.	7 Sta.	40 Sta.	25 Sta.
Hirudinea						
Erpobdella punctata (Leidy)	7 (32)	7 (12)				
Glossiphonia complanata (L.)*			19 (74)		2 (2)	
Helobdella stagnalis (L.)*			6 (20)			
Placobdella montifera (Moore)*			3 (3)			
Placobdella ornata (Verrill)*			1 (1)			
Haemopis grandis (Verrill)*		4 (7)	6 (9)			
Nephelopsis obscura (Verrill)*		2 (5)	5 (12)		2 (5)	
Dina parva (Moore)*			4 (15)			
Piscicola milneri (Verrill)*						1 (1)
Mysidacea						
Mysis relicta (Loven)						2 (20)
Isopoda						
Asellus sp.			9 (17)		1 (1)	
Lirceus sp.			9 (23)			1 (3)
Amphipoda						
Pontoporeia affinis Lindstrom			26 (198)		11 (23)	16 (68)
Hyalella azteca Saussure			3 (6)			
Gammarus fasciatus Say			1 (13)			
Gammarus pseudolimnaeus Bousfield			3 (5)		2 (7)	4 (7)
Crangonyx gracilis Smith			1 (3)			
Decapoda						
Orconectes virilis (Hagen)	12 (21)	49 (404)	12 (21)			
Orconectes propinquus (Girard)	3 (7)	27 (154)	2 (13)			
Cambarus bartoni (Fabr.)	1 (1)					
Ephemeroptera						
Ephemera simulans Walker			32 (Numerous)		7 (17)	
Hexagenia occulata Walker			42 (Numerous)			
Hexagenia rigida McDunnough			20 (Numerous)			
Hexagenia sp.			17 (106)		16 (161)	1 (1)
Baetisca sp.		4 (5)				
Siphloplecton sp.		1 (3)				

TABLE 1. — *Continued*

Species of Group	Goulais Bay Shores	Batchawana Bay Shores	Batchawana Bay Off-shore	Mountain Bay Shores	Mountain Bay Off-shore	Pigeon Bay Off-shore
	26 Sta.	98 Sta.	113 Sta.	7 Sta.	40 Sta.	25 Sta.
Plecoptera						
Acroneuria sp.		Several				
Odonata						
Macromia illinoiensis Walsh		14 (20)	7 (41)			
Cordulegaster maculatis Selys		4 (4)				
Gomphus sticatus Hagen		1 (1)				
Gomphus lividus Selys			4 (32)			
Ophiogomphus aspersus (?) [A]Morse			1 (1)			
Ophiogomphus c.f. *mainensis* Packard					2(Several)	
Didymops transversa Selys			1 (1)			
Hagenius brevistylus Selys			1			
Hagenius sp.		1				
Enallagma boreale Selys			3 (6)			
Enallagma cyathigerum ?			2 (Several)			
Basiaeschna janata (Say)		2 (Several)				
Unidentified			2 (6)			
Trichoptera						
Phryganeidae			3 (Several)			
Agrypnia sp.			1 (Several)			
Helicopsyche sp.			1 (1 e. c.)			
Molanna sp.			41 (Numerous)		10 (36)	
Leptoceridae			14 (Numerous)			
Leptocella sp.			3 (Several)			
Setodes sp.			1 (Several)			
Mystacides sepulchralis (Walker)			1 (6)			
Oecetis sp.			2 (Several)			
Athripsodes sp.			1 (Several)			
Limnephilidae			3 (3 e.c.)[B]			
Pycnopsyche sp.		9 (12)				
Limnephilus sp.		5 (7)				
Psychomyiidae			2 (Several)			
Lepidostoma sp.			1 (1)			
Unidentified			9 (Numerous)		8 (15)	1 (1)

TABLE 1. — *Continued*

Species of Group	Goulais Bay Shores	Batchawana Bay Shores	Batchawana Bay Off-shore	Mountain Bay Shores	Mountain Bay Off-shore	Pigeon Bay Off-shore
	26 Sta.	98 Sta.	113 Sta.	7 Sta.	40 Sta.	25 Sta.
Gastropoda[c]						
Limnaea stagnalis jugularis Say			7	1	1	
Stagnicola emarginata (Say)	2	3	24		2	
Fossaria obrussa (Say)			5			
Gyraulus parvus (Say)			19			
Gyraulus deflectus (Say)			23			
Gyraulus hirsutus (Gould)			2		2	
Helisoma anceps (Menke)		3	50		6	
Helisoma campanulatum (Say)			4			
Physa sp.	1	4	15		1	
Campeloma decisum (Say)	4	8	13			
Valvata sincera (Say)			29		19	9
Valvata tricarinata (Say)			37		12	
Valvata lewisi Currier			6			
Amnicola limosa (Say)			13		5	
Amnicola lustrica Pilsbry			10			
Goniobasis livescens Menke*	1		23			
Pelecypoda-Unionidae						
Anodonta grandis Say	5	5	28			
Anodontoides ferussacianus (Lea)*	1	1	3		1	
Elliptio complanatus (Solander)	8	3	10			
Lampsilis radiata siliquoidea (Barnes)	4	4	26			
Lampsilis ovata ventricosa (Barnes)		2	2			
Strophitus rugosus (Swainson)*	1					
Pelecypoda-Sphaeriidae						
Pisidium lilljeborgi Clessin			11 (31)		4 (5)	13 (35.5)[D]
Pisidium lilljeborgi f. cristatum			3 (12)			
Pisidium casertanum (Poli)*			3 (2.5)		1 (2)	6 (6)
Pisidium idahoense Roper*		1 (3)	5 (38.5)			
Pisidium idahoense f. indianense			9 (34)		13 (41.5)	13 (24)
Pisidium compressum Prime					5 (10.5)	
Pisidium variabile Prime*			2 (3)			
Pisidium nitidum Jenyns*			4 (10)			
Pisidium dubium Say			2 (1.5)			
Pisidium conventus Clessin			1 (3)			
Pisidium subtruncatum Malm*			4 (41)			
Pisidium ferrugineum Prime*			2 (3)			
Sphaerium striatinum (L.)	10 (102.5)		49 (984)			
Sphaerium striatinum f. emarginatum			25 (244)			
Sphaerium striatinum f. acuminatum		4 (46)	1 (2)		4 (39.5)	
Sphaerium nitidum Clessin*			16 (33.5)		4 (7.5)	14 (108)
Sphaerium lacustre Müller*			2 (2)			

TABLE 1. — *Concluded*

Species of Group	Goulais Bay Shores	Batchawana Bay Shores	Batchawana Bay Off-shore	Mountain Bay Shores	Mountain Bay Off-shore	Pigeon Bay Off-shore
	26 Sta.	98 Sta.	113 Sta.	7 Sta.	40 Sta.	25 Sta.
Fish						
Petromyzon marinus L.		49 (216)	3 (5)	1 (1)	1 (3)	
Lampetra lamottei (LeSueur)	2 (26)	53 (892)	4 (6)			
Ichthyomyzon sp.	1 (1)	54 (586)	2 (2)	4 (35)	2 (2)	
Osmerus mordax (Mitchill)		1 (1)				
Umbra limi (Kirtland)		1 (1)				
Alosa pseudoharengus (Wilson)		1 (1)				
Catostomus commersoni (Lacepede)		4 (5)		3 (4)		
Rhinichthys cataractae (Valenciennes)	1 (1)	21 (149)		3 (18)		
Notropis cornutus (Mitchill)	2 (12)	3 (3)				
Notropis hudsonius (Clinton)	4 (6)	16 (102)	2 (19)	2 (2)		
Notropis deliciosus (Girard)	12 (217)	31 (184)				
Notropis sp.	2 (9)	7 (22)				
Pimephales notatus (Rafinesque)	1 (1)	25 (71)				
Lota lota (L.)		2 (2)				
Icatalurus nebulosus (LeSueur)		2 (5)				
Eucalia inconstans (Kirtland)		1 (1)			1 (1)	
Pungitius pungitius (L.)		2 (2)		1 (2)		1 (4)
Micropterus dolomieui (Lacepede)	1 (1)	2 (2)				
Ambloplites rupestris (Rafinesque)	2 (4)	8 (14)				
Perca flavescens (Mitchill)		1 (1)				
Percina caprodes (Rafinesque)		1 (1)				
Etheostoma nigrum (Rafinesque)	10 (21)	67 (559)	14 (65)	4 (6)		
Etheostoma exile (Girard)		8 (14)	3 (11)			
Cottus cognatus (Richardson)			1 (1)			
Cottus bairdii (Girard)		61 (254)	12 (28)	6 (14)	1 (1)	1 (4)

NOTES: A. — Question marks following species indicate doubt regarding the identification.
B. — In Trichoptera "e.c." denotes empty pupal case.
C. — Numbers of gastropods were not recorded for each station.
D. — In Sphaeriidae fractional numbers refer to single shell valves.
* After specific names denotes new geographical records for Lake Superior.

in less than 6 m. *Glossiphonia complanata*, the most common species, was most frequent between 6 and 9 m as were *Helobdella stagnalis* and *Nephelopsis obscura*. *G. complanata* and *Dina parva* were the only two species collected in over 15 m of water.

Little has been published on the leech fauna of Lake Superior. Smith and Verrill (1871), whose records are also given by Meyer and Moore (1954), recorded three species of leeches for Lake Superior; only one of these, *Erpobdella punctata* was also present in these collections. It would appear that the other eight species taken are new records for the area. All but *Dina parva* were recorded by Ryerson (1915) for Georgian Bay, Lake Huron. *D. parva* has not been recorded previously from any of the Great Lakes.

CRUSTACEA : MYSIDACEA

Mysis relicta a species recorded from many deep Canadian lakes (Pennak, 1953) was collected at two stations in Pigeon Bay.

CRUSTACEA : ISOPODA

Isopoda were identified only to genera and were common only in Batchawana Bay; none were taken from greater than 30 m and they were most frequently collected between 6 and 15 m. *Asellus* sp. showed a tendency toward a somewhat deeper distribution than *Lirceus* sp..

CRUSTACEA : AMPHIPODA

The amphipod *Pontoporeia affinis* was the most frequently collected. The species is common in large deep lakes and rivers in Canada and the northern United States (Pennak, 1953; Bousfield, 1958). Since it is small, many specimens were probably lost and its abundance underestimated. The requirement of this species for cold water is reflected in its general and depth distribution. *P. affinis* was most abundant below 9 m in cold Pigeon Bay where it was present in 64 per cent of the hauls. In the warmer Mountain and Batchawana bays it was most frequent below 15 m but the species was less abundant, being present in 27 and 23 per cent of hauls respectively. *Gammarus pseudolimnaeus* showed a similar geographical distribution to *P. affinis* but was much less numerous. The other three species were taken only in Batchawana Bay, *Gammarus fasciatus* and *Crangonyx gracilis* down to only 6 m and *Hyallella azteca* down to 15 m.

The absence of *Gammarus limnaeus* from the collections is curious since Lake Superior is the type locality for this species.

CRUSTACEA : DECAPODA

The crayfish which were taken only in Batchawana and Goulais bays attracted the special attention of the author. Although most collections were qualitative, those made on Batchawana Bay shores in 1960 were quantitative, enabling definite conclusions on abundance and ecology of the two most common species, *Orconectes virilis* and *O. propinquus*. The third species collected, *Cambarus bartoni* was collected at only one station in Goulais Bay.

TABLE 2.—Sex distribution of crayfish catches from Batchawana Bay 1960

Month	*Orconectes virilis*				*Orconectes propinquus*			
	♂I	♂II	♀B	♀	♂I	♂II	♀B	♀
May	16	—	—	1	2	—	—	—
June	99	68	25	38	27	27	2	9
July	11	12	—	19	2	5	—	—
August	30	3	—	14	5	16	—	3
September	—	—	—	2	18	10	–	13
Totals	156	83	29	74	54	58	2	25
	239		103		112		27	
	342				139			

Symbols used: ♂I — first form male
♂II — second form male
♀B — female carrying eggs
♀ — female without eggs

Sex ratios and the proportions of first and second form males were recorded; this data is presented in Table 2. Males of both species greatly outnumbered females, the ratios being 2.2:1 for *O. virilis* and 4.5:1 for *O. propinquus*. It was notable however, that in the few collections from deep water females outnumbered males. Table 2 shows the seasonal variation of male forms and breeding females.

The observed preponderance of male crayfish is unusual, but this probably reflects different habits of the sexes rather than real numerical differences. Scanty evidence from deeper water suggest that females outnumber males there. Creaser (1933) discussing *O. propinquus* found females more numerous than males and Crocker (1957) who studied the species in New York found 55 per cent males in a population. Both those authors also found a seasonal variation, males being most numerous in May. There is little data in the literature on sex ratios of *O. virilis* but data given by Crocker (1957) suggest a fairly even balance in his collections. Changes in the proportions of first and second form males found in Batchawana Bay are similar to those detailed by Crocker for New York except that changes in Lake Superior occurred a little later in the year.

The distribution of the two species with regard to habitat was markedly different. *O. virilis* was commonest on sheltered shores where *Scirpus* sp. occurred. On wave-washed sandy shores with no cover, *O. virilis* was more numerous than *O. propinquus*, but neither was common. On exposed rock, boulder and gravel shores *O. propinquus* was the most abundant species and was also more common in local rivers even where these were slow and muddy. Descriptions of typical habitats for *O. virilis* vary, (Pennak, 1953; Crocker, 1957; Creaser, 1931; Meredith and Schwartz, 1960) but its preferred habitat in Batchawana Bay is not unusual. The species was collected down to 10 m but has been collected down to 31.5 m in Lake Michigan (Meredith and

Schwartz, 1960). One population at between 6 and 9 m was observed living in short burrows on a clay-mud bottom. *O. propinquus* is normally found on stony bottoms and not on silt (Pennak, 1954; Crocker, 1957). Most specimens collected in Batchawana Bay occupied typical habitats but specimens were also collected on sand and mud.

INSECTA : EPHEMEROPTERA

Mayfly nymphs were extremely abundant at many off-shore stations in Batchawana and Mountain Bays. Two genera *Ephemera* and *Hexagenia* were collected off-shore. *Ephemera* was typical of water less than 6 m deep, whereas *Hexagenia* was most frequent at stations between 9 and 15 m. In cool deep water *H. occulata* was commoner than *H. rigida*, but neither species was found at below 15 m in Mountain Bay. Only one specimen, a *Hexagenia* sp. was collected in Pigeon Bay.

INSECTA : ODONATA

All dragonfly nymphs taken were in less than 10 m of water, only *Macromia illinoiensis* and *Ophiogomphus* cf. *mainensis* were collected from below 6 m.

INSECTA : TRICHOPTERA

Only *Molanna* sp. and members of the *Leptoceridae* were numerous enough to permit conclusions about their depth distribution. *Molanna* sp. were most frequent at shallow stations but occurred to 15 m in Batchawana Bay and 30 m in Mountain Bay. *Leptoceridae* were also restricted to reasonably shallow water but were most abundant between 6 and 9 m.

INSECTA : DIPTERA

Members of the dipteran sub-family Tedipedinae were abundant at muddy off-shore stations. Collections have not been identified.

MOLLUSCA : GASTROPODA

Gastropods were collected from all the areas sampled; however, as shown in Table 1, the number of species decreased towards the west. No gastropods were taken below 30 m and few were taken deeper than 15 m. Only one species, *Valvata sincera*, was collected in cold Pigeon Bay. It was notable that pulmonate mollusca which are considered to normally breathe atmospheric air were not confined to very shallow water. Sixteen species of gastropods were collected, and the specific names used for them are those given by La Rocque (1953).

In Batchawana and Mountain Bays gastropods formed a major part of the benthic biomass.

Many species were abundant enough for conclusions about depth distribution to be made. *Stagnicola emarginata* and *Goniobasis livescens* were most abundant in less than 6 m. A second group comprising *Gyraulus deflectus*, *Helisoma campanulatum*, *Physa* sp., *Campeloma decisum* and *Valvata lewisi*

was also common in shallow water but was frequent to 9 m. A third group extended from shallow locations down to 15 m; this comprised *Limnaea stagnalis*, *Gyraulus parvus*, *Helisoma anceps*, *Valvata tricarinata* and *Amnicola limosa*. *Fossaria obrussa*, *Valvata sincera* and *Amnicola lustrica* were most frequently collected from 9 to 15 m, with the latter species showing a greater tendency toward deep water habitat.

All the species collected with the exception of *Goniobasis livescens* had previously been recorded for Lake Superior (Goodrich, 1939, 1945; La Rocque, 1953). *G. livescens* appears to be a new record for the lake although Goodrich (1945) recorded it from a tributary river. Dr. A. H. Clarke who identified many of the specimens noted the fact that some of the specimens of *Valvata sincera* from Mountain and Pigeon Bays exhibited loosely coiled shells similar to specimens from the Hudson Bay drainage (Clarke, 1964, *pers. comm.*).

MOLLUSCA : PELECYPODA : UNIONIDAE

As shown in Table 1, six species of unionids were collected but only one of these, *Anodontoides ferrussacianus*, was collected in Mountain Bay and none was taken from Pigeon Bay. *Elliptio complanatus* was commonly found along shores of Batchawana and Goulais Bays, its frequency of occurrence decreasing with increasing depth. It was not taken below 11 m. *Anodonta grandis* and *Lampsilis radiata siliquoidea* were also common on shores but extended into somewhat deeper water, being frequent between 6 and 9 m and present down to 15 m. Other species collected were not common enough to permit conclusions regarding distribution with depth.

All the species collected with the exception of *A. ferussacianus* and *Strophitus rugosus* have previously been recorded from Lake Superior (Goodrich and van der Schalie, 1932 and 1939; La Rocque, 1953; Clarke and Berg, 1959). *A. ferussacianus* appears to be a new record but is not unexpected since it had previously been collected in Lakes Huron and Michigan. *S. rugosus* is normally an inhabitant of creeks and small streams, from which it has been collected in this general area (Goodrich and van der Schalie, 1939). Clarke and Berg (1959) gave its distribution in the Great Lakes system as "Lake Huron eastwards". It would therefore appear to be a new record for Lake Superior.

MOLLUSCA : PELECYPODA : SPHAERIIDAE

Sphaeriids were encountered in all four bays and at all depths. They were abundant in many samples and in Pigeon Bay formed a majority of the benthic biomass at several stations. Seventeen species and forms were identified from the collections as shown in Table I.

Of the thirteen species of Sphaeriidae collected, only five were previously recorded for Lake Superior (Heard, 1962b). The following eight species appear to be new records: *Pisidium casertanum*, *P. idahoense*, *P. variabile*, *P. nitidum*, *P. subtruncatum*, *P. ferrugineum*, *Sphaerium nitidum*, and *S. lacustre*. However, all these species, except *S. lacustre*, have been collected in lakes in Isle Royale in Lake Superior and from either Lake Huron, Lake Michigan or

both. *S. lacustre* has apparently been recorded previously from only one of the Great Lakes, Lake Ontario (Heard, 1962a; Heard, 1962b; Herrington, 1962).

Several differences in depth and geographic distribution were noted. One group, comprising *P. lilljeborgi*, *P. casertanum*, *P. compressum*, *P. nitidum*, *P. subtrunsatum*, and *S. nitidum*, seemed to be characteristic of cold, deep water. Of this group, *P. compressum* was limited in its distribution to Mountain Bay and *P. nitidum* and *P. subtruncatum*, were restricted to Batchawana Bay towards the eastern end of Lake Superior. The typical species of warm shallow water and shores clearly was *S. striatinum*. No other species was abundant in this habitat, although the data suggest that *P. variabile* and *P. dubium* belong to this group. The status of *P. idahoense* is enigmatic since in relatively warm Batchawana Bay and relatively cold Pigeon Bay, it appeared typical of cold, deep water whereas in Mountain Bay it was most frequent at shallow water stations. Further confusion is added if the form *indianense* is considered separately. In Batchawana Bay the species (senso stricto) was found at shore stations and the form *indianense* only at stations below 6 m of water. In Pigeon Bay also, this form occurred only below 6 m, but in Mountain Bay the same form was most common at less than this depth.

FISH

Ammocoetes of the lampreys *Petromyzon marinus*, *Entosphenus lamottei* and *Ichthyomyzon* sp. were taken in fairly large numbers in the lake as shown in Table 1. Ammocoetes were formerly considered typical of lotic environments but recently increased lamprey research has shown them to occur in lakes (Hansen and Hayne, 1962; Wagner and Stauffer 1962a, Wagner and Stauffer 1962b). In this study ammocoete populations were shown to extend over two miles into the lake from the Batchawana River mouth and to lesser distances from other rivers. They were found in both shallow and deep water, one specimen of *Ichthyomyzon* sp. being taken in 23 m of water in Batchawana Bay. Ammocoetes must be considered to constitute a normal part of lentic, benthic situations where recruitment from spawning rivers is possible.

Many of the other fish collected are not benthos in the strict sense of the term. However, most live in association with the bottom resulting in their incorporation in these collections. In general, as shown in Table 1, more fish were collected in shore shocking operations than with the anchor dredge and poisoning techniques, undoubtedly because all the species collected were active enough to escape those latter two methods.

During shore surveys in Batchawana Bay in 1960, every effort was made to collect all the fish within the sample area. While collections were not complete enough to give quantitative results, they present evidence of the relative abundance and habitat of the more common species. *Etheostoma nigrum* and *Cottus bairdii* were almost ubiquitous on shores, occurring at 88 and 93 per cent of stations respectively. *Rhinichthys cataractae* was collected at 65 per cent of stations in rock, boulder or gravel covered shores and 28 per cent of stations on exposed sandy shores, but was absent in sheltered locations. Other species did not show such clear habitat preferences, but there were some

notable differences in distribution. *Etheostoma nigrum* was common in all locations, but was most abundant on the exposed sandy shores; it seems typical of such locations in the area. The common cypriniform fishes, *Notropis hudsonius*, *Notropis deliciosus*, and *Pimephales notatus*, all showed similar broad habitat preferences, being most common on sheltered shores with a growth of *Scirpus* sp. and least common on exposed sandy shores. *Cottus bairdii* was very common in all areas surveyed, but fewer specimens were collected on exposed sandy shores than elsewhere.

None of the fish collected are new records for the general area, but the data provide evidence of relative abundance and habitat in an area where little intensive fish-collecting, particularly in lentic environments, has been carried out.

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I am deeply indebted to many workers in the U.S.A. and Canada who freely gave their skill and time to identify specimens in these collections. They are as follows:

Dr. E. L. Bousfield, National Museum of Canada, identified all Amphipoda and Isopoda collected in 1959 and identified representative crayfish.

Dr. F. P. Ide of the University of Toronto made determinations on Ephemeroptera collected in 1959.

Dr. G. B. Wiggins, Royal Ontario Museum, identified all Trichoptera collected in 1959.

Dr. J. B. Burch and Mr. N. J. Reigle of the Museum of Zoology, University of Michigan, identified most of the Gastropoda collected in 1959.

Dr. Henry van der Schalie of the Museum of Zoology, University of Michigan, identified most of the Unionidae and Gastropoda of the genera *Amnicola* and *Physa* collected in 1959.

Dr. W. Heard of the Museum of Zoology, University of Michigan, identified Gastropoda of the genus *Valvata* collected in 1959.

Rev. H. B. Herrington of Westbrook, Ontario identified all Sphaeriidae collected and also gave encouragement and advice when needed.

Dr. E. M. Walker of the Royal Ontario Museum identified all Odonata collected in 1959.

Dr. P. S. Corbet, Experimental Biology Section, Canada Department of Agriculture, Central Experimental Farm, Ottawa, identified all Odonata collected in 1960.

Dr. J. E. Moore of the University of Alberta identified all Hirudinea.

Dr. A. H. Clarke, Jr., National Museum of Canada, identified all Gastropoda and Pelecypoda : Unionidae collected in 1960.

Dr. J. A. Oughton, Ontario Agricultural College, identified some Unionidae collected early in 1959.

All identifications other than those detailed above were made by the author who accepts full responsibility for any errors.

I would also like to express my gratitude to the following of my colleagues at the Fisheries Research Board of Canada, Biological Station, London, who gave unselfishly of their time, both within and outside the bounds of duty:

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ANALYSIS OF THE MOVEMENT AND GROWTH OF JUVENILE BROOK TROUT (*SALVELINUS FONTINALIS*) FROM ROTENONE COLLECTIONS TAKEN IN THE NABISIPI RIVER AND VICINITY, QUEBEC

G. Power
Department of Biology, University of Waterloo, Waterloo, Ontario, and
Ministry of Tourism, Fish and Game, Province of Quebec

Introduction

The brook trout, *Salvelinus fontinalis*, has found its way into almost every body of water draining into the eastern part of the north shore of the Gulf of St. Lawrence. It occurs in all the large river systems, penetrating to the headwaters and inhabiting even the smallest tributary streams. Along the coast it is found in all streams, even those which appear hardly large enough to support a resident fish population. Many of these populations are completely unexploited which adds considerably to their interest. There is no doubt that it is the most abundant and successful species of freshwater fish inhabiting this area. In 1961 and 1962, while the author was working at the Quebec Government research station at Nabisipi River, collections of fish were made using rotenone both in Nabisipi River and in many small streams in the vicinity of the research station. The fish fauna of the region has been described and details of the collecting stations given by Power (1965). In this paper information derived from a study of trout in the collections is reported. Two locations are dealt with in detail, Nabisipi River, 30 miles from the coast and Grand Ruisseau a small stream on the coast. These locations contrast, the former being an average to good trout habitat for this region, the latter being a poor habitat. Collections from other places provide data for comparison.

Material and Methods

Grand Ruisseau is a small stream seven miles long which enters the sea one mile east of Nabisipi River. The lower part of the valley is very uniform. The stream runs parallel to the coast in a steep-sided, flat-bottomed channel cut through raised sand beaches. It averages 25 feet wide and nine inches deep. The stream bottom is of sand and what little cover there is for fish is provided by a few partly buried decaying logs which provide anchorage for patches of filamentous algae. The water is brownish and slightly cloudy especially after rain. The sandy bottom of the stream is fairly easily disturbed and this adds to the turbidity of the water during sampling. Eleven collections of trout were made in this stream – the first on August 16, 1961, in the lower portion of the stream. Nine samples were obtained in 1962 from the same part of the stream. Beginning on June 7, successive sections of stream were rotenoned every two weeks until September 27. The first section began above the mean high tide mark and later sections began progressively farther upstream. Two

persons were involved in each sampling operation. One added emulsified rotenone mixed with water to the top of the sample area over about a ten minute period. The second stood at the bottom of the sample area and attempted to pick up all the affected fish. He was later joined by the first person and the sample area was scoured until no more fish could be found. This generally took 1½ hours and involved at least six traverses of the sample area. After this a second collection of fish was made in the part of the stream between the sample area and the coast. Again this area was scoured until no more fish could be found. Sampling was always done at low tide when the estuary provided a large very shallow settling basin for dead and dying fish and it was felt that few if any fish were washed to sea. After the first 4 samples were obtained this way, it became apparent that more fish were being collected below the sample area than in it. Different procedures of sampling were adopted on August 2 and 16 to find out if fish taken below the sample area had escaped from it during sampling or had in fact taken up residence in the areas cleared of fish during previous samples. On August 16 and 30 attempts to estimate the percentage recovery of killed fish were made by releasing marked fish in the sample area before sampling. The scheme of sampling in the lower part of Grand Ruisseau in 1962 is shown in Figure 1. One other sample was obtained from the headwaters of the western branch of Grand Ruisseau on August 1, 1962 (Station 10c in Power 1965) and this provides data for comparison with the downstream samples. Along with trout, insignificant numbers of eels, threespine and ninespine sticklebacks were taken in Grand Ruisseau.

For obvious reasons Nabisipi River could not be sampled so intensively. Between July 16 and September 25, five samples were obtained using rotenone in a small branch of the river behind an island, just below Grande Chûte, which is 30 miles from the sea. There was much more cover for fish here than in Grand Ruisseau. The bottom was covered with a thin layer of gravel lying over grey clay. There were also some larger, flat stones. The current was slight, the maximum depth was 18 inches and the width varied greatly but probably averaged about 60 feet. Since the same area was killed in each sample, after the first sample, only new immigrants to the area were available. These presumably moved in from the main river in search of new territories. An additional large collection was made August 20, 1962, in a small branch of the river about five miles above Grande Chûte. In these parts of Nabisipi River trout occur in about equal numbers with juvenile Atlantic salmon. A few threespine and ninespine sticklebacks also occur here. Other samples of trout were obtained in Nabisipi River but these were generally small collections. The water in the river is clear at all times making recovery of killed fish appear relatively easy.

Other locations in the general vicinity from which samples of trout were obtained were described and given station numbers by Power (1965). They are: Tributary of Lac Saumur, July 9, 1962 (Station 8); Tributary of Lac Michaud, July 17, 1962 (Station 5); Tributary of Nabisipi River, August 4, 1961 (Station 11); Tributary of Aguanus River, August 9, 1961 (Station 9d); Small stream, 1.5 miles west of Nabisipi River, August 10, 1962 (Station 12).

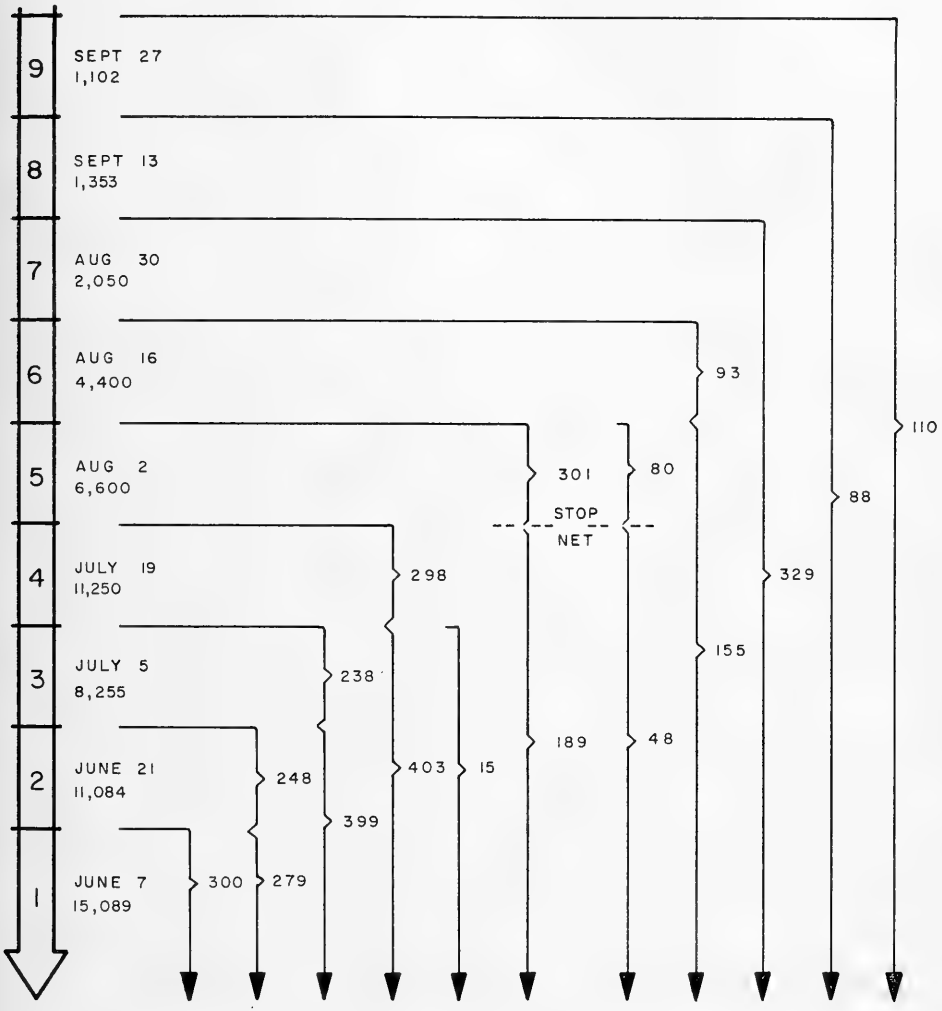

FIGURE 1. Sampling scheme, Grand Ruisseau 1962, giving date, area in square feet and number of trout fry collected in each section.

All fish taken in rotenone collections were deposited immediately in 5 per cent formalin. They were examined either later the same day or the next day. Generally this only involved measuring the fork length to the nearest millimeter.

RESULTS

Before describing the collections in detail, information derived from the sampling in Grand Ruisseau in 1962 will be considered. This has some general

implications in regard to the use of rotenone for sampling trout populations in streams.

Escape from the sample area and downstream movement

In Grand Ruisseau conditions were such that it was felt unnecessary to employ a stop net below the sample area. Although the water was somewhat turbid during sampling, visibility was good and the current slight. In the lower reaches 96 per cent of the trout taken were fry and the following details refer only to the fry. On June 21, July 5 and July 19, more fry were collected below the sample area than in it. In addition, fry collected below the sample area were significantly larger than those taken in it. The pertinent figures are — June 21: sample area, 248 fry, mean length 32.22 ± 0.37 (95 per cent confidence interval around mean); below sample area, 279 fry, mean length 33.19 ± 0.36 mm; — July 5: sample area, 238 fry, mean length 34.25 ± 0.41 mm; below sample area, 399 fry, mean length 37.83 ± 0.33 mm; — July 19: sample area, 298 fry, mean length 36.53 ± 0.38 mm; below sample area, 403 fry, mean length 38.40 ± 0.35 mm. This result immediately raised the question, had fry taken below the sample area escaped downstream during sampling? If not they must have recently moved into the depopulated parts of the stream where, as a result of reduced competition, they grew faster. On August 2, sampling was arranged to find which of these alternatives was true. First, the section of stream below the July 19 sample area was killed. Only 15 fry were collected indicating quite definitely that any downstream movement that may have occurred in the two week interval between samples was slight. Second, the August 2 sample area was rotenoned and a stop net placed at the lower boundary to try to prevent fry escaping. The result was not quite satisfactory, the nature of the bottom being such that it was impossible to use a net effectively. In the sample area, 301 fry were obtained, mean length 37.62 ± .43 mm; below the sample area, 189 fry, mean length 39.15 ± .60 mm. These 189 fry must have originated from the area between the August 2 and July 19 sample areas or have escaped downstream from the August 2 sample area. It is suspected many of them had in fact escaped from above and this is confirmed to some extent by their greater average size. Rotenone works more slowly on bigger fish and these are perhaps more active and better able to escape detection when swimming downstream from the sample area. On August 16, two samples were again taken. The first was taken in the August 2 sample area with a stop net below. Eighty fry were taken in the August 2 sample area and 48 below. The majority of these fry had probably been living in the upper part of the August 2 sample area and had moved down a short distance from above to exploit the territory depopulated two weeks before. The second sample was taken in the August 16 sample area, no stop net was employed and many fish were picked up below the sample area. Confirmation of the relative immobility of the trout fry in Grand Ruisseau was obtained on the night of August 29. At night many of the trout fry move into the very shallow water at the edge of the stream and are easily visible by lantern light. No fry were encountered working up the stream until just

below the August 16 sample area where one was seen. The density of fry gradually increased towards the top of the August 16 sample area. It was concluded from these observations that under normal conditions little or no movement of trout fry would occur during the summer months in Grand Ruisseau and even under the unusual conditions provided by the sampling very little downstream movement occurred. The remaining samples covered the whole stream area, rotenone being added at the top of the sample area and fish being picked up downstream with no attempt to reconfirm the observations on lack of movement. In Nabisipi River, below Grande Chûte, where the same area was poisoned in repeated samplings, some fry moved into the depopulated branch of the river in the interval between samples but the density never appeared to reach the initial level. Judging by the situation of the sampling area it would seem that trout fry were more mobile here than in Grand Ruisseau.

Percentage of recovery

If the rotenone sampling technique is to be useful for describing the structure of natural populations of stream fish it must provide the total population from a limited area or an unbiased sample of the population. Grand Ruisseau appeared to be perfect for obtaining almost complete recovery of all killed fish. Even fry were conspicuous against the rust coloured sand bottom and there were few hiding places. The initial experiment to measure the percentage recovery was not successful. Twelve hours before sampling, 100 fish were caught and released with dorsal fin clips in the August 16 sample area. There were 98 fry and 2 older fish. During sampling 41 of the fry were taken giving a 42 per cent recovery. Both older trout were recovered but this was not unexpected since they are very obvious when affected by rotenone. What was surprising was the poor recovery of marked fry. Subsequently 12 others were recovered in later upstream samples but the total recovery rate of 54 per cent was unbelievably low. In a repeat of the experiment on August 30 the marked fry were released into the sample area immediately before sampling so that there was no chance of losses through mortality or movement. Twenty-five fry with the anal fin clipped were released and 13 recovered giving a recovery rate of 52 per cent. Forty fry with dorsal and anal clips were released and 28 recovered, a 70 per cent recovery rate. These figures were again surprisingly low. They emphasize the difficulty of obtaining an almost complete recovery of stream fish killed by rotenone. Grand Ruisseau was considered an ideal place for good recovery. In most streams the cover is better and recovery rates may be even lower. In view of the poor performance in Grand Ruisseau it was concluded that while rotenone samples may be useful in describing the growth of stream trout populations they are of little value for estimation of mortality rates of fry or for description of population density or structure during the first year of life unless combined with some technique for estimating recovery rates. A recent paper by Boccardy and Cooper (1963) on the use of rotenone and electro-fishing in surveying small streams confirms this conclusion. In a number of trout streams examined by

TABLE 1.—Sizes of trout fry during first summer

Location	Date	Mean fork length mm. ± 95% confidence interval and standard deviation ( )	Number in sample	Observed range mm.
Grand Ruisseau (1) (lower part)	Aug. 16, 1961	42.24 ± 0.43 (4.57)	442	30 – 59
	June 7, 1962	28.14 ± 0.29 (2.58)	300	21 – 36
	June 21, 1962	32.73 ± 0.23 (2.68)	527	22 – 45
	July 5, 1962	36.49 ± 0.32 (4.13)	637	24 – 49
	July 19, 1962	37.61 ± 0.27 (3.60)	701	26 – 49
	Aug. 2, 1962	38.18 ± 0.36 (4.08)	505	24 – 52
	Aug. 16, 1962	39.51 ± 0.54 (5.32)	376	24 – 53
	Aug. 30, 1962	39.74 ± 0.59 (5.35)	327	24 – 53
	Sept. 13, 1962	40.25 ± 1.19 (5.64)	88	28 – 53
	Sept. 27, 1962	40.55 ± 0.96 (5.09)	110	28 – 51
(headwaters) (10c)	Aug. 1, 1962	39.80 ± 0.94 (4.83)	101	28 – 50
Nabisipi River (Grande Chûte)	July 16, 1962	44.89 ± 0.72 (4.72)	167	30 – 55
	Aug. 3, 1962	49.89 ± 1.07 (4.79)	79	38 – 60
	Aug. 20, 1962	54.00 ± 0.99 (4.98)	98	44 – 67
	Sept. 7, 1962	57.35 ± 1.11 (4.71)	71	49 – 70
	Sept. 25, 1962	57.08 ± 3.84 (6.11)	12	50 – 72
(Above G. Chûte) (2)	July 16, 1962	46.40 ± 2.94 (4.11)	10	38 – 54
(3)	Aug. 20, 1962	57.08 ± 0.52 (5.16)	390	47 – 70
15 miles above sea (6)	July 18, 1962	41.79 ± 1.92 (5.04)	29	32 – 50
(7)	July 30, 1962	45.35 ± 1.37 (5.47)	65	33 – 61
5 miles above sea (10)	Aug. 8, 1961	47.29 ± 2.05 (4.52)	21	37 – 58
(13)	July 24, 1962	51.29 ± 2.00 (4.73)	24	44 – 61
Tributary of Lac Saumur (8)	July 9, 1962	31.50 ± 0.41 (3.36)	68	23 – 38
Tributary of Lac Michaud (5)	July 17, 1962	39.22 ± 0.63 (3.51)	128	29 – 51
Stream 1½ miles W. Nabisipi (12)	Aug. 10, 1962	48.50 ± 1.66 (5.05)	38	37 – 58
Stream ½ mile W. Nabisipi (11)	Aug. 7, 1961	56.00 ± 4.85 (8.10)	13	41 – 70
Tributary of Nabisipi River (4)	Aug. 4, 1961	52.86 ± 3.71 (4.15)	7	47 – 60
Tributary of Aguanus River (9d)	Aug. 9, 1961	52.00 ± 3.46 (3.46)	6	47 – 57

these authors they found recovery rates in rotenone collections which varied from 64 to 90 per cent. They felt there was no means of judging the efficiency of the collecting method from an appraisal of stream characteristics in the sample area.

Growth

In rotenone samples, taken during the summer, fry can easily be separated from older fish. In a few cases it is possible to recognize trout in their second (1+) and third (2+) summer. Overlapping of lengths between age groups makes it impossible to go beyond this. In Table 1 data on the growth of fry is summarized. For each location the date of the sample, the number of fry, the mean fork length with 95 per cent confidence intervals, the standard

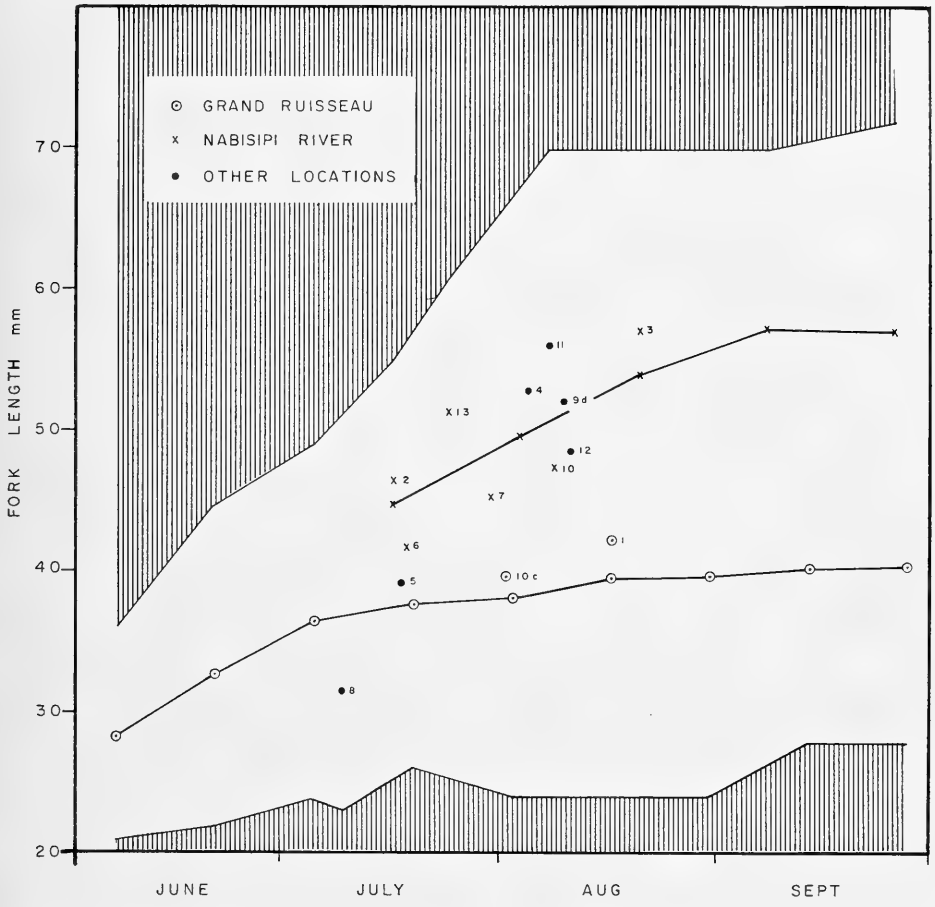

FIGURE 2. Growth curves for trout fry in Grand Ruisseau and Nabisipi River, Grande Chûte. The mean lengths of trout fry in other collections are shown and identified by number as in Table 1. The unshaded area includes the largest and smallest trout fry taken in any of the samples and indicates extremes in the growth spectrum of trout fry in the Nabisipi region of Quebec.

deviation and the observed range is given. In figure 2 the data is presented graphically. The growth curves for Grand Ruisseau and Nabisipi River, Grande Chûte, are given and mean lengths of trout fry in the other samples indicated and identified by number. The growth spectrum for trout fry in the region is shown by the unshaded area. This area includes the largest and smallest fry observed in any of the samples taken and indicates the range of growth rates encountered amongst trout fry in the region. In Grand Ruisseau June and early July is the important period for growth. The trout fry grow about 2 mm per week during this interval. Later in the summer growth is slow. During the latter half of July, August and September only 4 mm is

TABLE 2.—Estimated sizes of yearling trout in some rotenone samples

Location	Date	Mean fork length mm. ± 95% confidence interval and standard deviation ( )	Number in sample	Observed range mm.
Tributary of Lac Saumur	July 9, 1962	72.73 ± 2.55 (12.63)	97	48 – 101
Nabisipi River Grande Chûte	July 16, 1962	87.50 ± 3.01 (6.80)	22	72 – 96
Grand Ruisseau Headwaters	Aug. 1, 1962	81.30 ± 3.51 (13.83)	61	56 – 116
Nabisipi River Above G. Chûte	Aug. 20, 1962	105.69 ± 2.05 (10.09)	96	81 – 130
Grand Ruisseau Lower reaches	June 7 to July 19, 1962	58.05 ± 1.22 (4.78)	61	48 – 69

added to the length. Nabisipi River trout fry attain much larger sizes by the end of summer because they maintain their initial rate of growth for a much longer period. It is not until the end of August that their growth begins to slacken obviously.

The length-frequency distributions of some of the samples where it is possible to recognize trout in their second summer, are shown in Figure 3. All these samples come from habitats where the cover was moderately good and reasonable numbers of yearling trout were taken. It is easy to divide fry from older trout, but to separate yearlings from older fish is much more difficult and in fact, without using some independent method of age determination, it can at best only be considered tentative. In Table 2 the data derived from the distributions shown in Figure 3 are given, together with some data on the size of yearling trout in the lower reaches of Grand Ruisseau. It was felt unwise to estimate the sizes of older trout from the samples, although numbers of trout in their third summer were present in some of the samples. The problem is that larger and more successful older trout have probably left the streams and backwaters in which rotenone collections can be made so that estimates of size of older trout are likely to be biased downwards. In addition the separation of age groups becomes too tenuous beyond the yearling stage.

DISCUSSION

The results indicate the variability in growth of trout fry and in some cases older trout in Nabisipi River and streams in the vicinity. Nabisipi River is felt to represent an average to good habitat for trout in this region and fry attain a mean length of 58 mm in September. This is poor growth compared with the size attained by trout fry in other parts of the species' range. In Lawrence Creek, Wisconsin, McFadden (1961) found the average size of trout fry to be 101 mm in September. In Mud Lick Run, an infertile headwater tributary of the Allegheny River, Pennsylvania, trout fry had attained a mean length of

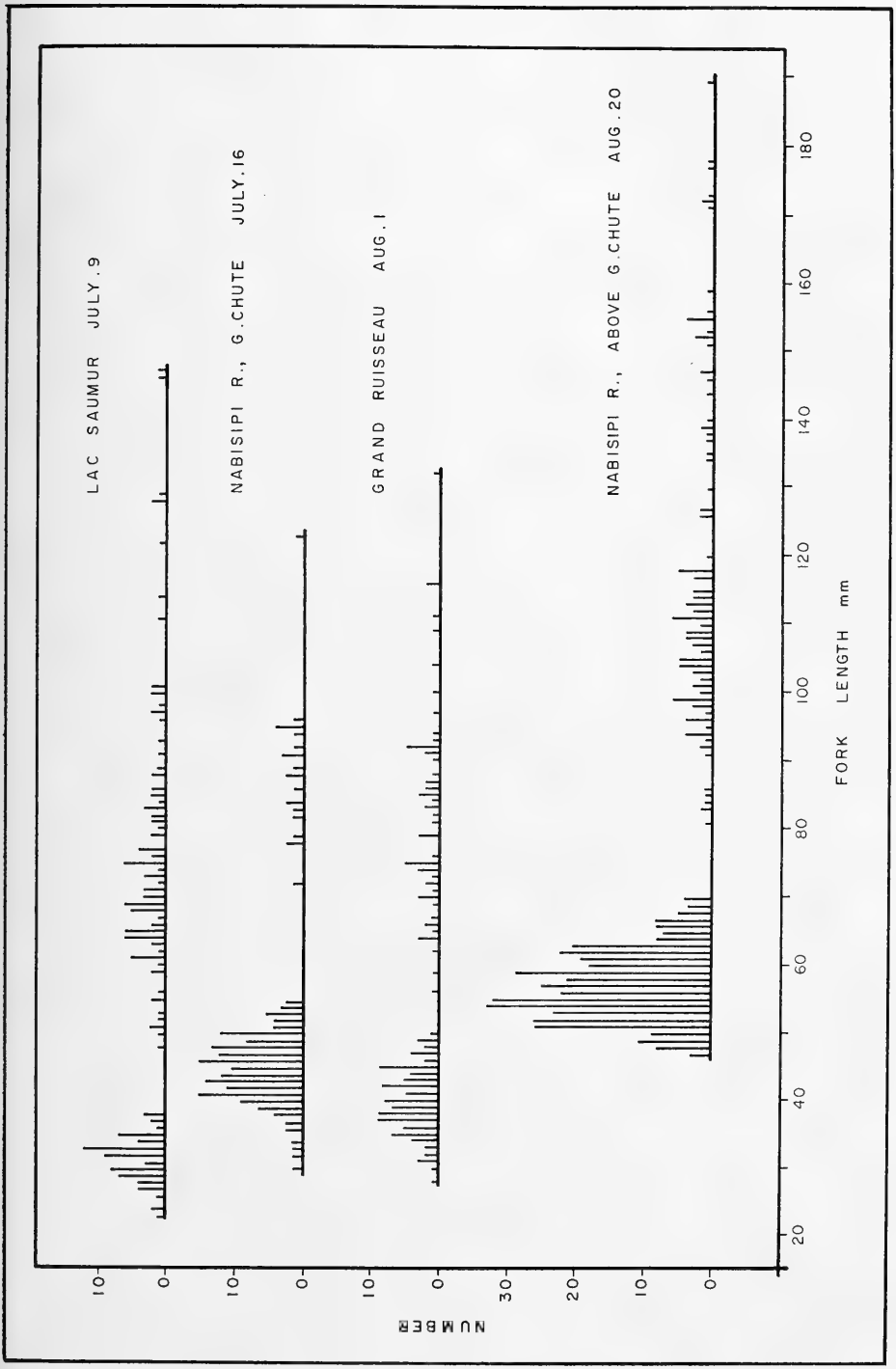

FIGURE 3. Length-Frequency distributions of trout in some rotenone samples from habitats where the cover was moderately good. Recognition of fry and yearling trout is possible in these samples.

61 mm by August 8. (Cooper, Boccardy and Anderson 1962). Even in the Ungava region of Quebec, Power (1966) reported the average size of trout fry at the end of the summer to be 60 mm. By contrast, in the lower parts of Grand Ruisseau trout fry attain an average length of only about 41 mm by the end of September. The slow growth in this stream represents an extreme adaption in the life cycle of the brook trout to marginal conditions.

What causes slow growth in small streams like Grand Ruisseau is uncertain. The most obvious difference between it and Nabisipi River is in the amount of cover and the temperature regime. The amount of cover is not likely to be important. Fry in the sample obtained in the headwaters of Grand Ruisseau on August 1 were almost identical in size with those in the lower part of the stream but the amount of cover was vastly different in the two locations. Grand Ruisseau is a cold stream fed to a considerable extent by cold seepage water which throughout the summer remains at about 3°C. This cold water percolates in through the banks of the stream and flows along the edges. At night particularly, many trout fry live in this water. Temperatures in the middle of the stream depend on the day. The highest temperature recorded was 15°C. in the estuary. In the sample areas 12°C. was the highest temperature but 9°C. the average during June to September. On cold overcast days the temperature fell as low as 5°C. Nabisipi River, on the other hand, had mean monthly temperatures of 12.5°C. June, 16.5°C. July, 17.5°C August and 14.0°C. September. Not withstanding these differences in temperature it seems hardly possible that low temperatures alone can explain the poor growth of fry in Grand Ruisseau. During June they grew well enough in cold water. Stunting of the population was caused by an early end of the initial period of relatively rapid spring growth. Fry densities in Grand Ruisseau after the end of June varied from 1 fry per 4.5 square feet to 1 fry per 11 square feet (calculated from the data in Figure 1 with adjustment for a 70 per cent recovery rate in sampling). Lower densities perhaps occurred in June when the stream was swollen, but the apparent difference is more likely to be due to a lower recovery rate of very small fry and the downstream location of the June sample areas. It is not known whether overcrowding and lack of sufficient suitable food was responsible for retarding the growth of trout fry in Grand Ruisseau during most of the summer. Cooper *et al.* (1962) in their study of the trout in Mud Lick Run were of the opinion that the slow growth of trout in that stream was not caused entirely by competition for food and space. A severe reduction in the trout population in this stream was not followed by a substantial increase in trout growth. It would seem then that factors other than temperature, food, space and cover may operate to limit the growth of speckled trout in small streams. A more detailed analysis of the situation is required.

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OBSERVATIONS ON THE BEHAVIOUR OF NESTING THREE-TOED WOODPECKERS, *PICOIDES TRIDACTYLUS*, IN CENTRAL NEW BRUNSWICK

ROBERT S. GIBBON
Stewiacke, Nova Scotia

ON May 16, 1965, the nesting site of a pair of Northern Three-toed Woodpeckers, *Picoides tridactylus*, was discovered some twelve miles southeast of Boiestown, New Brunswick, by P. A. Pearce and M. Jackson. During the summer of 1965 Pearce, Jackson, and the writer were employed with the Canadian Wildlife Service on a project to determine the effects on birds of the pesticides used in the control of spruce budworm, *Choristoneura fumiferana*, and were doing a post-spray survey when the nest was found. I was not in the immediate vicinity at the time and did not see the nest until nearly an hour later. Being particularly interested in woodpeckers, I was, however, given an opportunity to carry out some observations on the nesting behaviour of these birds.

The nest was located sixteen feet up in the trunk of a dead trembling aspen, *Populus tremuloides*, with a somewhat N shaped curve near its base. Because of the peculiar shape and decayed condition of the trunk, it was felt unwise to climb the tree and, therefore, the number of eggs and later young was never actually determined. Three smaller trees formed a crude semicircle at a distance of about thirty feet from the front of the nesting tree. These were numbered from left to right as trees nos. 1, 2, and 3 and will be referred to frequently in the text. Behind the nesting tree were several acres of slashings, and to the front, some seventy-five feet away, was a well used logging road, which the entrance faced. The area on the opposite side of the road was composed of mature conifers only sparsely culled.

When the nest was discovered both the male and female were present. However, when Pearce first observed the site on the mornings of May 17 and 19, no bird was in sight, but the male, which was apparently brooding, was brought to the entrance when the tree was tapped at the base with a small stick. After each tapping he would appear but would soon withdraw and remain inside. On May 26, I flushed the male three times by first tapping the trunk and then moving the stick to within a few feet of the entrance. He would fly to trees nos. 1 or 2, sit quietly and preen himself for a few minutes and then fly back to the nesting tree. Upon his return he would alight slightly below the entrance, make a short hop and enter the cavity where he would remain until the process was repeated. A similar experience was encountered with the female on May 27. From these observations it is seen that these birds were not particularly restless or wary in close proximity to their nest. This is somewhat contradictory to the observations of Brewster (*in* Bent 1939) who found them extremely alert around their nesting site.

On the evening of June 8, the feeding cries of young were audible as a low but excited rattling hum and resembled those of young Black-backed Three-toed Woodpeckers, *Picoides arcticus* (Erskine 1959, Gibbon 1964). The male was seen returning to the nest at 1827 hrs. (The time given here and elsewhere in the text is Atlantic Standard Time.) He first alighted on tree no. 2, and then flew and landed about two feet below and slightly to the left of the entrance. By moving in a clockwise direction around the back of the tree he proceeded to the entrance. He then paused momentarily, entered the hole and fed the young. This approach method had been described (Roberts *in* Bent 1939 and Erskine 1959) in regard to nesting *P. arcticus;* therefore, to determine if a similar method was used frequently by *P. tridactylus,* a small sketch was made of a section of this nesting tree and all subsequent observations of the adults approaching the entrance were marked. Out of a total of eighty-nine approaches noted, eighty-six were made by the birds alighting a few inches below the entrance and entering it directly; one was by the spiral method mentioned above; and the other two were made by the birds alighting some two feet below the entrance and approaching it by making several short hops. This method, also described previously (Brewster *in* Bent 1939), did not appear to be utilized frequently by this pair.

To determine the rate of feeding and general activity around the nest during the early portion of the day, I set up a blind on June 18, which was at a distance of some thirty feet from the nest and in which I stayed from 0320 to 1240 hrs. The male left the nest at 0405 and the young began to chatter at 0429 hrs. The male returned at 0435 and fed the young. When he left the nest a few minutes later he was carrying a fecal sac in his bill. In regard to this it should be mentioned that during the time I observed the nest, feces were removed a total of sixteen times, and at all times this was done by the male.

The number of feedings per hour appeared to fluctuate considerably (Figure 1) and the male fed the young more frequently than did the female by a ratio of 2.36:1.

A considerable amount of vocal communication appeared to exist between the male and the female. Generally this consisted of excited chattering sounds

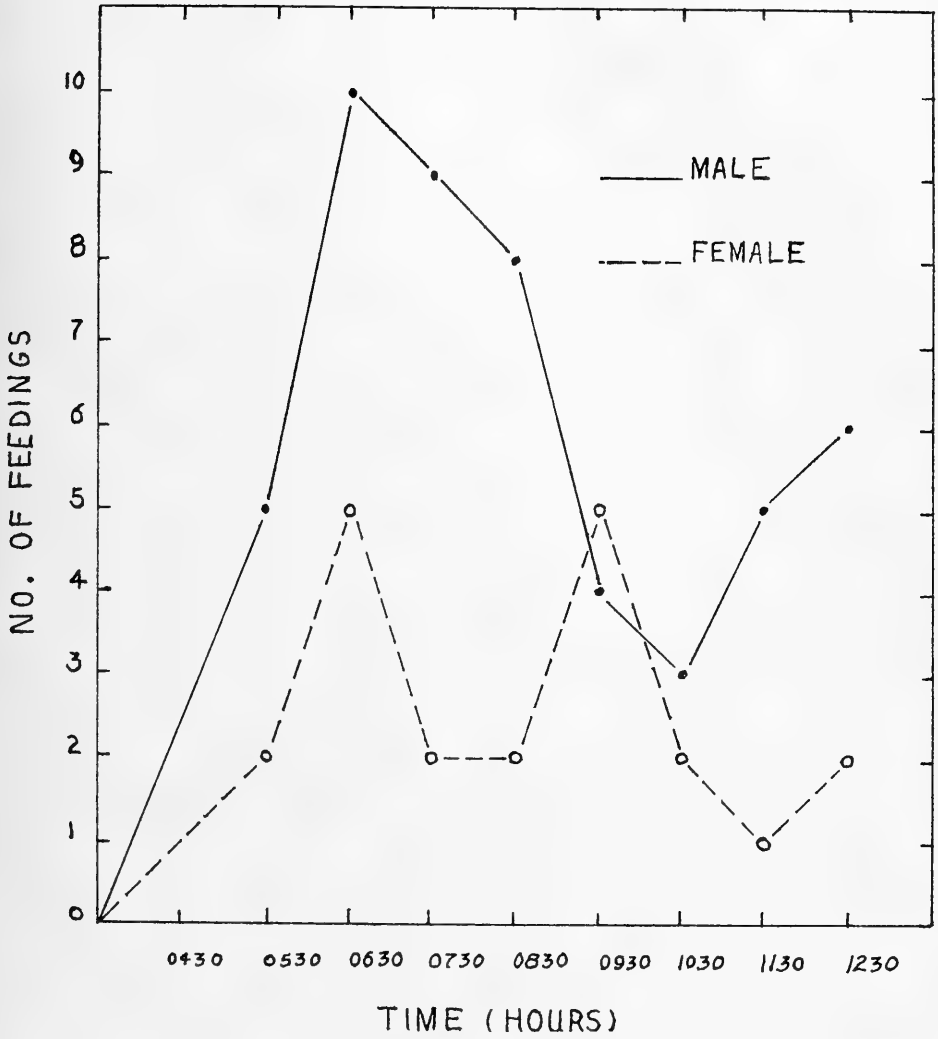

FIGURE 1. Fluctuation in the number of times the young were fed per hour during the morning of June 18.

emitted by both parents if they happened to approach the nest consecutively. However, several times it was noted that after the female fed the young she would fly to the top of the nesting tree, alight on one particular dead limb, give two or three drumming sounds and then sit quietly preening herself for several minutes before flying. These drummings were characterized by being short in duration (one to two seconds) and starting with a few slow taps and gradually increasing in tempo toward the end. The actual significance of this was not determined although after the drumming it was the male who returned, usually within three minutes, and each time feces were removed by him.

The adults paid little attention to any other species of birds that approached the nesting site except for other members of the family Picidae. On these occasions three combats were noted. The first of these occurred on June 15 and involved the female *P. tridactylus* and a female Yellow-bellied Sapsucker, *Sphyrapicus varius*. The second and third occurred during the morning of June 18. Both of these struggles involved the male *P. tridactylus*; the first being with a female Hairy Woodpecker, *Dendrocopos villosus*, and the second a male *P. arcticus*. These combats consisted chiefly of the birds dashing at each other, followed by vigorous wing-flappings and chatterings and terminating with short scuffles on the ground.

The nest was visited on the afternoon of June 21. The young were present and resting in the entrance. This was a hot afternoon (about 85°F.) with high humidity and a strong wind blowing. The adults were observed several times clinging to the shady side of trees nos. 1 and 3. This may have been done to keep out of the sun or to keep out of the wind for both were coming from the same general direction.

Pearce visited the site on June 24 and found the nest void of life except for a Tree Swallow, *Iridoprocne bicolor*, flying around the entrance. He felled the tree and collected the section containing the nest. From this the following dimensions were taken (in inches): outside dimension of the entrance, 1.7; outside vertical dimension of entrance, 1.8; inside diameter of entrance, 1.7; depth of cavity below entrance, 11.0; diameter of tree at entrance, 4.8. The approximate height of the tree was 28 feet. The entrance was facing in a southeasterly direction.

This is apparently the first authentic published breeding record for this species for the Maritime Provinces. It should be noted, however, that Baxter (*in* Squires 1952) stated that it had been found nesting in New Brunswick, but he established no definite record.

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NUMERICAL TAXONOMY AND THE SMELT FAMILY, OSMERIDAE

D. E. McAllister
National Museum of Canada, Ottawa, Ontario

Introduction

Before the methods and principles of numerical taxonomy are accepted in their entirety or in part, it is necessary to compare their results with those of conventional taxonomy and to evaluate the differences. Using some of the methods of numerical taxonomy this paper makes a re-analysis of a recent conventional revision of the smelt family, Osmeridae (McAllister, 1963) and compares the results of the two studies. The source of the methods of numerical taxonomy used herein is Sokal and Sneath (1963). For further background material see the symposium *Phenetic and phylogenetic classification* of the Systematics Association (1964) and discussions in the pages of Systematic Zoology of recent years.

According to the principles of numerical taxonomy the selection of characters should be random; a minimum of 60 characters would seem advisable and never less than 40 should be used. It should be made clear that the data for the numerical taxonomic portions of this paper are drawn from a previous taxonomic study in which only 48 characters were analyzed. The data are, therefore, not ideal, though adequate for a numerical taxonomic study. But by using the same basic data for the two studies, the differences may more easily be attributable to the methods, rather than to the characters selected.

Methods

The methods used in this similarity study are among those outlined in Sokal and Sneath (1963) (to which the following page references refer).

The characters were coded by a simple present (+) or absent (0) scheme (p. 76). Every character was known and applicable so NC entries were not necessary (p. 74). The characters were arranged along one axis of the table, the taxa (or operational taxonomic units) along the other. For example, four axinosts were present (scored +) in all forms except *Mallotus* (scored 0), in which there are six. Subspecies were not included in this study since their differences, of a partially overlapping nature, were not amenable to + or 0 scoring.

The following characters were coded; the alternative to each is "not", e.g. proethmoids double (proethmoids *not* double). Which of the alternatives is indicated by + or 0 is of no significance (in this method). The characters are: glossohyal teeth canine; maxillary extends past mid-eye; proethmoid double; otic bulla wide anteriorly; posterior myodome opening narrow; with parasphenoid wing joining prootic; mandible shallow; palatine dumbbell-shaped; dorsal edge of pterygoid straight; metapterygoid with dorsal vane over

TABLE 1.—Two by Two Table for Computation of Coefficients of Association

	S. l.	S. t.	S. s.	O. e.	T. p.	A. e.	H. p.	H. t.	H. o.	M. v.
S. l.	x									
S. t.	31 1 1 15	x								
S. s.	30 1 2 15	30 1 2 15	x							
O. e.	24 4 8 12	24 4 8 12	22 6 9 11	x						
T. p.	26 6 6 10	23 8 9 8	21 10 10 7	24 7 4 13	x					
A. e.	26 6 6 10	25 7 7 9	26 6 5 11	24 8 4 12	24 8 7 9	x				
H. p.	12 7 20 9	13 6 19 10	12 7 19 10	12 7 16 13	9 10 22 7	10 9 22 7	x			
H. t.	12 7 20 9	12 3 20 13	11 4 20 13	10 5 18 15	6 9 25 8	7 8 25 8	15 0 4 29	x		
H. o.	11 4 21 12	12 3 20 13	10 5 21 12	10 5 18 15	6 9 25 8	7 8 26 7	15 0 4 29	14 1 1 32	x	
M.v.	12 14 20 2	12 14 20 2	11 14 21 2	12 14 16 6	14 12 17 5	13 13 19 3	14 12 5 17	10 16 5 17	10 16 5 17	x

hyomandibular head; dorsal fork of posttemporal long; frontal with lateral wings over orbit; vomerine teeth small; palatine teeth small; subopercle and/or opercle with striae; snout to dorsal length equals or exceeds dorsal to caudal; midlateral ridge in males; elongate midlateral scales; gill rakers 25 or more; pyloric caeca never more than 8(9); with blind stomach sac; midlateral scales always above 70; anal rays up to 23; pectoral rays 16-23; lateral line complete; length of adipose base never exceeds orbit; orbit 2/3 or less of caudal peduncle depth; mesethmoid simple; parietals not at all separated; pterosphenoid reaches parasphenoid wing anteriorly; no slit between hyomandibular and preopercle; actinosts 4; ventrals 8; dorsal 10-14; vertebrae 64 or more; branchiostegals 8-10; head 4.7 or less in standard length; pectoral always 70 per cent or more of distance to pelvic; pelvic origin anterior to dorsal; peritoneum silvery; marine; pyloric caeca obsolescent; ductus pneumaticus attaches to anteriormost end of gas bladder; gill rakers long; standard length exceeds 200 mm; mouth horizontal; range attains or exceeds 60° N. Lat.

In plus or minus coding some information is lost because the finer variations are excluded. This can be avoided to some extent by double coding. Note above the pyloric caeca are coded as 8(9) or less (or not) and obsolescent (or not).

Table 2.—Coefficients of Association (SM)

	S. 1.	S. t.	S. s.	O. e.	T. p.	A. e.	H. p.	H. t.	H. o.	M. v.
S. 1.	x									
S. t.	.96	x								
S. s.	.94	.94	x							
O. e.	.75	.75	.69	x						
T. p.	.75	.65	.58	.77	x					
A. e.	.75	.71	.77	.75	.69	x				
H. p.	.44	.48	.46	.52	.33	.35	x			
H. t.	.44	.52	.50	.52	.29	.31	.91	x		
H. o.	.48	.52	.46	.52	.29	.29	.91	.96	x	
M. v.	.29	.29	.29	.38	.40	.33	.65	.56	.56	x

S.1. — *Spirinchus lanceolatus*
S. t. — *Spirinchus thaleichthys*
S. s. — *Spirinchus starksi*
O. e. — *Osmerus eperlanus*
T. p. — *Thaleichthys pacificus*
A. e. — *Allosmerus elongatus*
H. p. — *Hypomesus pretiosus*
H. t. — *Hypomesus transpacificus*
H. o. — *Hypomesus olidus*
M. v. — *Mallotus villosus*

After the coding basis is set up the different characters are recorded as + or 0 for the different species in a table (not shown, but above characters for all the species are recorded in McAllister, 1963). From this a two by two table for computation of coefficients of association is compiled, Table 1. This table compares, for all the possible different pairs of taxa (or operational taxonomic units), the number of characters which were ++ (positive in both taxa), +0 (positive in the first, negative in the second taxon), 0+ (negative in the first, positive in the second taxon) and 00 (negative in both taxa).

The simple matching coefficient used in this study is calculated by $S_{SM} = m/n = m/(m + u)$, where S_{SM} is the simple matching coefficient, m is the number of characters in "matched" cells (++ or 00) and u is the number of characters in "unmatched" cells (= 0 or 0+) and n is the total number of characters. In other words the simple matching coefficient is the number of characters which the two taxa share divided by the total number of characters.

The simple matching coefficients for all the pairs of taxa are calculated from the two by two table (Table 1) and presented in Table 2.

The coefficient is a measure of how close the two taxa are (i.e. how many characters they share). The higher the coefficient is, up to 1.00, the closer the two taxa. The lower the coefficient is, down to 0.00, the more distant the two taxa.

In order to more easily understand how the different genera are related to one another a further table is provided, Table 3. The pairs of genera are listed

with the most closely related pairs at the top of the table. When a genus is polytypic the coefficient given is the mean of the coefficients between each of its species and the other genus.

TABLE 3 — Coefficients of Association Between Pairs of Genera Arranged in Order of Magnitude (closest genera first)

Osmerus-Thaleichthys	77
Osmerus-Allosmerus	75
Allosmerus-Spirinchus	74
Osmerus-Spirinchus	73
Thaleichthys-Allosmerus	69
Thaleichthys-Spirinchus	66
Mallotus-Hypomesus	59
Osmerus-Hypomesus	52
Spirinchus-Hypomesus	48
Thaleichthys-Mallotus	40
Osmerus-Mallotus	38
Allosmerus-Mallotus	33
Allosmerus-Hypomesus	32
Thaleichthys-Hypomesus	30
Spirinchus-Mallotus	29

PRIMITIVENESS

The lack of fossil smelts different from extant species[1] forces use of other measures of primitiveness. Gosline (1960) suggests that the superfamily Salmonoidea gave rise to the Osmeroidea and the author agrees that this may be so. Of the Salmonidae, the Salmoninae appear to be closest to the required ancestor of the osmeroids, the Thymallinae and Coregoninae having various specializations which would bar them from ancestry. The paired proethmoids are clearly primitive, being paired in the esocoids. If the Salmoninae (*see* Norden, 1961 for some characters) are close to the ancestors of the smelts then certain characters may be regarded as primitive. The following character states may be regarded as primitive relative to the family Osmeridae: (1) branchiostegals numerous, more than 8; (2) mouth horizontal; (3) adipose fin oval; (4) scales numerous, more than 100; (5) mandible shallow; (6) glossohyal teeth not villiform; (7) peritoneum not black; (8) lateral line complete; (9) pyloric caeca numerous; (10) stomach without blind sac; (11) ventral rays numerous; (12) no opercular striae; (13) spawn in freshwater; (14) midlateral scales not elongate in male; (15) no anal shelf in male; (16) no midlateral ridge in male; (17) four simple axinosts; (18) parietals separated by supraoccipital; (19) vomerine teeth equal in size to palatines; (20) large adult size, more than 300 mm; (21) maxillary extending to mid-pupil or past; (22) proethmoids double, not fused.

Using the data in McAllister (1963) the number of primitive characters which are found in the different genera is given in Table 4. Then, according to this method, *Thaleichthys* would be the most primitive genus and *Mallotus* the most advanced.

[1]See Appendix regarding *Thaumaturus*, and fossil otolith of *Hypomesus*.

Table 4 — Number of primitive characters in different genera

Thaleichthys	16
Osmerus	15
Spirinchus	12
Allosmerus	12
Hypomesus	10
Mallotus	8

Discussion of Results

Comparison with Previous Studies

Classification involves categorization, erection of hierarchies and recognition of phylogeny (although some proponents of numerical taxonomy would not admit the latter). The distinctness of the taxonomic categories previously recognized is confirmed by the present study. The results of the last two operations in the two studies are compared below.

Hierarchies: The coefficients of association may be used to assess or establish the status of categories. The lower taxa will be more closely related, that is have higher coefficients of association.

In this regard the level of the taxa recognized in the last revision of the family appears to have been correctly assessed, relative to one another in the hierarchy. The species within a genus (in *Spirinchus* and *Hypomesus*) are more closely related, coefficients of 91-97, than the genera within a sub-family, 59-77, or than the genera between different subfamilies, 29-52.

Could other taxa have been recognized? In the foregoing study none of the species of the polytypic genera, *Spirinchus* and *Hypomesus*, were considered so highly distinguished as to warrant superspecific or subgeneric categories, nor with so few species was a need felt for such categories. The calculated coefficients agree with the conclusions from the previous study that the species of *Spirinchus* were very close, 94-96. So subgeneric categories do not seem to be indicated. In the genus *Hypomesus* the coefficient of association would indicate that *H. pretiosus* was more distinct, 91, than the other two species, 96. On this basis it might be possible to recognize a superspecies for *H. pretiosus*. It may be pointed out here that in the previous conventional study *H. olidus* was considered the most distinctive species in the genus (as indicated in the key, p. 27). The reasons for this are twofold. First, in coding, information was lost in differences in pyloric caeca. Secondly the point of juncture of the ductus pneumaticus, notably behind the anterior end of the gas bladder in *H. olidus*, is a feature unique in the family and was considered of more significance than the other characters (such as number of vertebrae which was found to vary within subspecies). However, the exact level of distinctness which might be recognized for superspecies is basically an arbitrary decision, as would be more readily apparent in a larger genus where a spectrum of differences would be found. It seems superfluous to recognize slightly marked species by superspecies when utility is not served. Minor degrees of affinity are best indicated in phylogenetic dendrograms (i.e. the author does not adhere to the cladistic

point of view – *see* Mayr, 1965, p. 167). Supertaxa are useful when they help divide speciose groups. This is not to say that monotypic taxa should not be recognized when they are sufficiently distinctive.

A case might be made for the recognition of separate subfamilies for *Mallotus* and *Hypomesus*. The differences between genera of the two subfamilies presently recognized range from 29 to 52. The genera *Mallotus* and *Hypomesus* are only slightly less different, differing by a coefficient of 57. Deciding the level of coefficient at which to recognize subfamilies appears to be more arbitrary (in this family) than that between species and genera.

Phylogeny: Certain proponents of numerical taxonomy do not believe that phylogenies can be erected solely on the results of study of living species. These persons may regard the following discussions and figures as referring simply to the similarity of living species, not to their phylogeny.

In constructing a phylogeny of the subfamily Osmerinae tables 3 and 4 may be referred to. From the coefficients of association one may conclude that *Osmerus* and *Thaleichthys* are the most closely related genera and that *Allosmerus* is quite close to *Osmerus*. *Allosmerus* and *Spirinchus* are the next most closely related pair. The number of characters considered primitive would indicate that *Thaleichthys* is the most primitive, being closely followed by *Osmerus*. *Allosmerus* and *Spirinchus* are the most advanced and have achieved the same degree of advancement. The two sets of results appear compatable and are easily translated into a phylogenetic tree, with *Thaleichthys* at the bottom and *Allosmerus* and *Spirinchus* at the top, and with *Osmerus* in an intermediate position (*see* Figure 2).

Hypomesus and *Mallotus* obviously branch from a common stalk. As the most advanced genus, *Mallotus* must take the most distant position. Computing the mean coefficient of association for the subfamily Hypomesinae (average of its two genera) with each of the osmerin genera gives the following results: with *Osmerus* 45, *Spirinchus* 38.5, *Thaleichthys* 35 and *Allosmerus* 32.5. From these figures one would conclude that the Hypomesinae branched off from the Osmerinae close to *Osmerus* on the stem which gave rise to *Spirinchus*. The major features of all these relationships are depicted in the dendrogram given in Figure 2. (Although the relative positions can be indicated easily on a two dimensional figure, it does not appear practical to indicate the exact distances between all taxa without using three dimensions).

The major differences between the phylogenies suggested may be seen by comparing Figures 1 and 2. The first difference is that the positions of the genera *Spirinchus* and *Thaleichthys* are reversed, the latter being indicated as the most primitive by the numerical taxonomic study. Secondly the numerical taxonomic study suggests that the Hypomesinae are closer to *Osmerus* than to *Spirinchus*. Otherwise the generic relationships suggested by the two studies are similar.

A proper evaluation of the results of the two methods will only come when a knowledge of fossils will enable one to delineate the phylogenies on factual instead of theoretical bases. An evaluation might also be made when further taxonomic data are available, the author might suggest the worthiness of chro-

mosome, blood and muscle protein[1] electrophoritic and serum studies. It is not suggested that any one of these will provide *the* answer but that each will contribute to a more certain phylogeny. The present author's personal subjective evaluation is that the new numerical analysis has contributed to the understanding of generic relationships. He is not sure that numerical analysis has correctly assessed the relationships within the genus *Hypomesus*.

Comments on Numerical Taxonomy

The following are some general critical comments on numerical taxonomy. They are not intended to comprise a complete critique. For further comments one may refer to the pages of Systematic Zoology.

Numerical taxonomy has criticised conventional taxonomy on a number of scores. Some of its charges have been valid, but others apply only to certain workers in conventional taxonomy and should not be made against the field of conventional taxonomy. Take for example the number of characters employed. Many poor conventional studies do employ too few characters. However there are many conventional studies which have employed the minimum number of characters or well above the minimum which numerical taxonomists consider necessary. To cite a few examples in the field of ichthyology: Briggs (1955) used a least 50 in his revision of the Order Gobiesociformes; Norman (1934) used at least 60 characters in his revision of the flatfishes; Katayama (1960) in his revision of the Japanese Serranidae used at least 75 characters. Moreover, the minimum suggested by Sokal and Sneath, perhaps valid for their groups, may not be valid for other groups. My colleague, Dr. Arthur H. Clarke, Jr., informs me that for the freshwater molluscs on which he is working at the moment it would be difficult to find 30 meaningful taxonomic characters, let alone the suggested absolute minimum of 40.

At present the coding of data in numerical taxonomy does not seem wholly capable of absorbing all data available. For example body part ratios of different species may be discrete at any one size, but the ratios over the whole size range (which would be used for coding) overlap. A series of overlapping ranges of meristic or proportional characters for different forms would be quite difficult to code, but can be dealt with in conventional studies. However, these difficulties in coding may not prove insurmountable and could be dealt with now by setting these characters aside for special handling, at least in smaller groups.

The non-weighting of characters has been one of the most difficult of principles of numerical taxonomy for others to accept. The present author can see certain cases where he might consider that characters are of approximately equal value, e.g. where in certain groups the dorsal and anal fin ray counts might be equivalent, and they to a scale count differences, or perhaps to a colour or even a behavior pattern. In higher classification it would be difficult to weight certain of the more important characters such as protrusibility of the jaws, presence of maxilla in gape of the jaws, presence of true

[1]Dr. Hiroshi Tsuyuki and the author are engaged in a joint study using muscle proteins in the Osmeridae to help determine relationships.

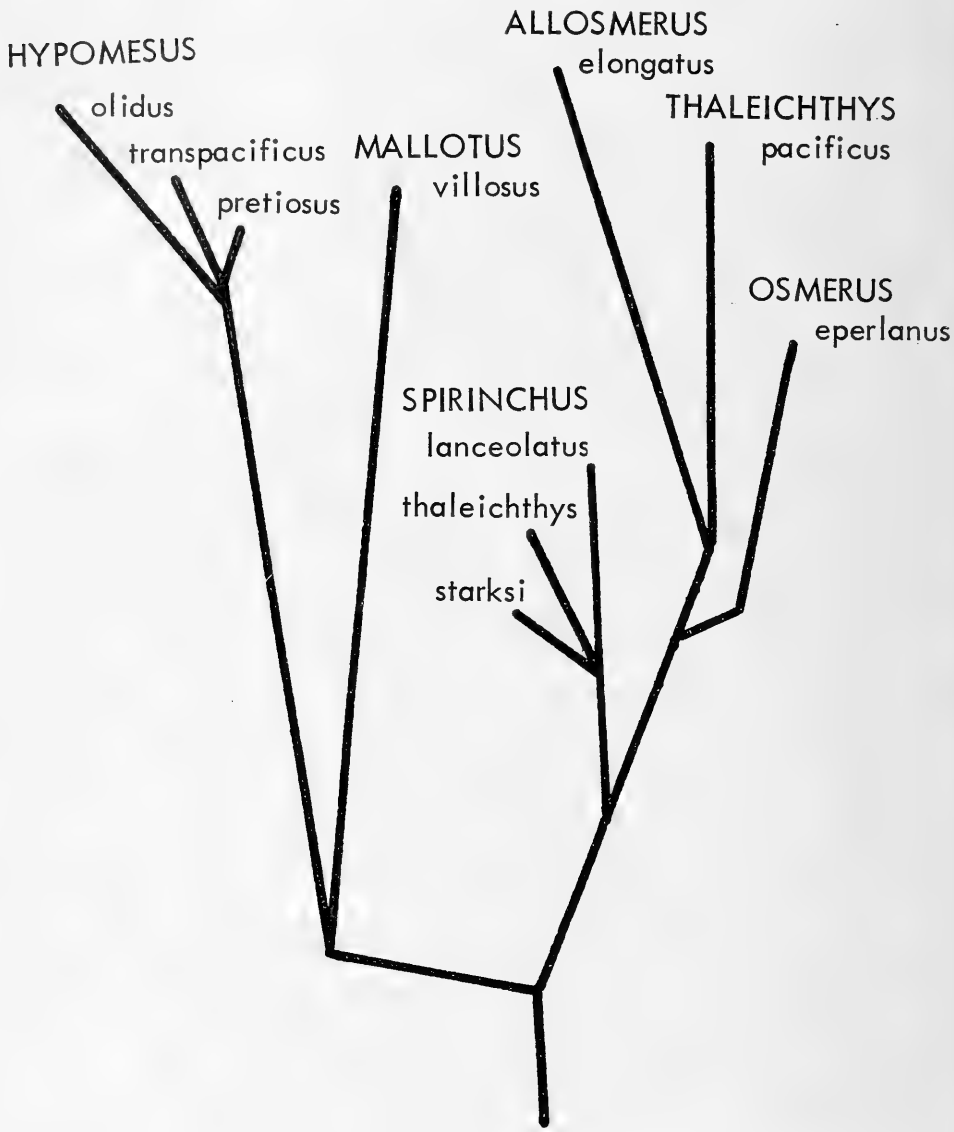

FIGURE 1. Phylogenetic dendrogram derived from a conventional taxonomic study (McAllister, 1963).

fin spines, physostomous or physoclistic gas bladder, etc. But other characters are clearly of different worth, e.g. the principal caudal rays as opposed to the variability in anal rays in many groups, or of a trenchant osteological character as opposed to a colour pattern. This would make one less willing to equate all characters with one another. It must be admitted that there would be some difficulty in deciding how much to weight characters. However it would

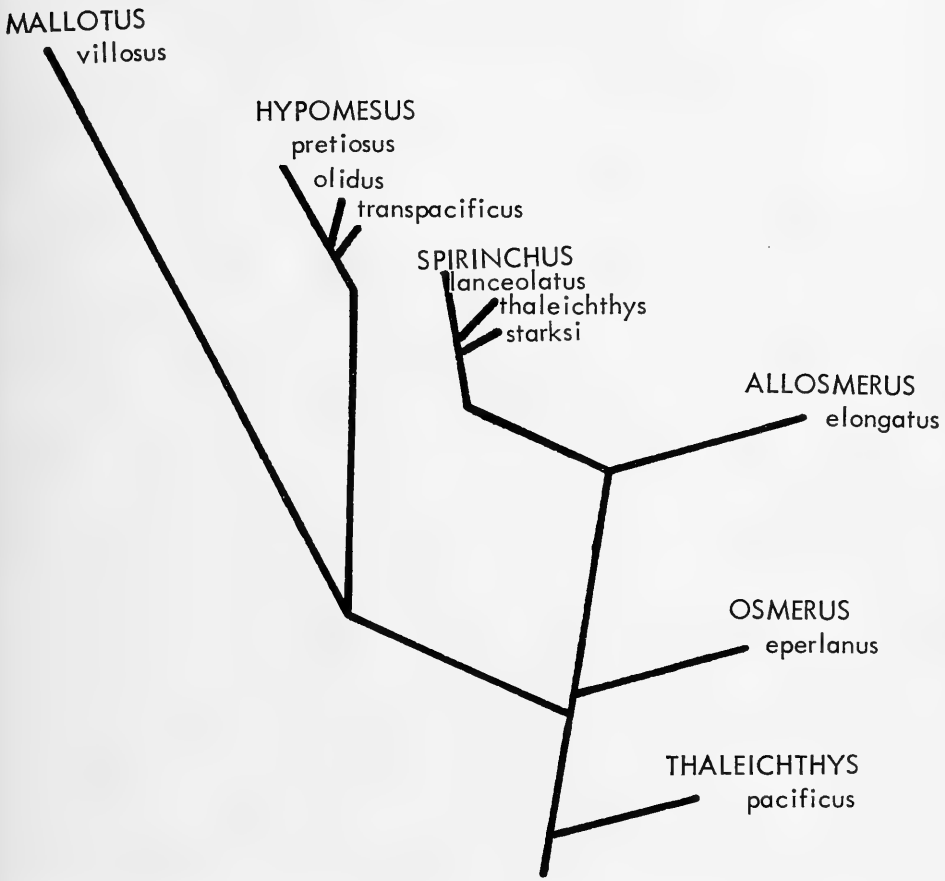

Figure 2. Phylogenetic dendrogram based on the present study using methods of numerical taxonomy.

be relatively easy to make a rule of the thumb ratio, 2:1, 3:1 or other simple ratio, after preliminary study of a group, for weighting — before any systematic decisions had been made. Nor is it difficult to conceive of some basis for a less subjective weighting formula. This would weight characters more strongly when they displayed constancy within taxa and showed correlation with other independent characters[2]. By weighting some characters the loss of valuable information might thereby be avoided. In this regard taxonomists might be reminded that they need not accept all the precepts of numerical taxonomy. The suggestion to separate phylogeny and classification is probably a century too late.

The simple consideration of the number of diagnostic characters will not permit deciding whether a form is a species or subspecies. Here must be

[2]Ignoring taxonomically spurious correlations such as those due to large size in the close parts because of a common growth centre, those resulting solely from inhabiting the same ecological niche, etc.

evaluated factors such as percentage separation, degree of interbreeding, sympatry, information on behaviour and ecology, etc. Information may be incomplete for any one factor. The geographical distribution of intermediates between two types will influence interpretation of status. Sibling species may differ little morphologically[3]. Here it will be difficult for numerical taxonomy to supplant the experienced systematist. It is probably in the establishing of comparable taxa above the species level that numerical taxonomy will have its greatest use. Also in the use of many characters to establish relationships in morphologically complex groups; here it is difficult for the systematist to hold all the characters in his mind in analyzing affinities.

There are a number of features of value in numerical taxonomy. It provides a standard approach which may be taken for all groups. It provides a rational series of steps and bases on which to proceed. These assist toward attaining repeatability and objectivity. The use of numerous characters, which it advocates, should raise the quality of classification.

While all of the tenets of numerical taxonomy may not be acceptable, these and the restating of the bases of taxonomy will challenge zoologists to rethink the philosophy of systematics. The quality of taxonomy will still depend to a large degree on the care and accuracy of the taxonomists, the adequacy of the series of specimens he studied in terms of number, geographic representation, sex, etc., and his thoroughness in studying even the less accessable characters. While numerical taxonomy will probably not supplant conventional taxonomy it will perhaps help make and rejuvenate it, and lead the way to a new and superior systematics.

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SUMMARY

The data of a conventional taxonomic study of the smelt family (McAllister, 1963), Osmeridae, was re-analyzed using some of the methods of numerical taxonomy as propounded by Sokal and Sneath (1963). A primitiveness score was introduced. The results of the two studies were then compared. The allotment of species to genera, and status of the various taxa in the studies agreed closely. The (phylogenetic) relationships shown were close, but not identical, differing in reversal of positions of *Thaleichthys* and *Spirinchus* (the former now being considered primitive, the latter advanced) and in the derivation of the subfamily Hypomesinae from the stem closer to *Osmerus* than to *Spirinchus*. The use of classical and numerical methods have resulted in very

[3]A student at the University of Ottawa, Claude Delisle, has discovered two populations of *Osmerus eperlanus mordax* in a lake in the Gatineau area, Quebec, one composed of giant-, the other of normal-sized individuals. Brief examination of a series of these by the author showed several differences, the most significant of which was the number of gill rakers. However, the number of gill rakers did overlap. Data like this is difficult to handle with numerical taxonomy. See also Svardson (1961) who reports morphologically similar populations spawning at different times.

similar taxonomic pictures. Comments are made about numerical taxonomy and its future.

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Appendix

The Miocene fossil genus *Thaumaturus* was first placed in the family Salmonidae. Later it was accorded familial distinction close to the Salmonidae by Voigt (1934) and Berg (1947). Norden (1961) in his study of the osteology of the Salmonidae considered the Thaumaturidae were likely allied to the Argentinidae or Osmeridae, judging by a description and figure of a single caudal vertebral centrum. However Voigt (1934) figures a specimen with 2 or three upturned caudal vertebrae which would distinguish *Thaumaturus* from even the superfamily Osmeroidae. Other characters of Voigt's material also distinguish it from the Osmeridae: 40 instead of 51-78 vertebrae; lack of flanges on the posterior neural spines; posterior position of the dorsal fin partly overlying the anal base; body deep instead of slender; presence of intermuscular bones; shallowly forked caudal; lack of dermethmoids; premaxillary bordering 2/3 of gape (instead of 1/3) presence of teeth on the shaft of the vomer; lack of supramaxillary. Further differences may be seen in comparing Chapman

(1941) and Rembiszewski (1964) with Voigt (1934). These characters together indicate a rather distant relationship of *Thaumaturus* to Osmeridae.

In agreement with McAllister (1963), Bigelow (1964) reduces the Atlantic American form of smelt to a subspecies, *Osmerus eperlanus mordax*. He reduced the Pacific capelin (considered consubspecific by McAllister, 1963) to a subspecies of the Atlantic form but realized that Arctic specimens might change the conclusions.

Stinton (1963) has described a new species, *Hypomesus glaber* from otoliths in Miocene deposits, Victoria, Australia. Zoogeographically this would be an interesting find, as all previously-known living and fossil osmerids were in the northern hemisphere. One wonders if the otoliths might actually belong to one of the southern hemisphere families closely related to the Osmeridae — the Galaxiidae, Retropinnidae or Aplochitonidae. However an otolith from a New Zealand specimen of *Galaxias* and from one of *Retropinna* were quite different.

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SIEVE MESH SIZE AS RELATED TO VOLUMETRIC AND GRAVIMETRIC ANALYSIS OF CARIBOU RUMEN CONTENTS

GEORGE W. SCOTTER
Canadian Wildlife Service, Edmonton, Alberta

ANALYSIS of rumen content is probably the most common method employed to determine the food habits of ruminants. The method offers obvious advantages when dealing with a highly mobile species, such as barren-ground caribou (*Rangifer tarandus groenlandicus*), which may move several miles per day. Other methods, such as direct observation of feeding, require long hours of field work and cause many problems in logistics. In contrast, rumen analysis can be completed in the laboratory. Buechner (1950) listed some of the limitations of feeding minute studies as applied to pronghorn antelope (*Antilocapra americana*). Most of the limitations also would apply to a study of the feeding activities of barren-ground caribou.

The present study was undertaken to determine which sieve mesh size, if any, would separate the forage into portions representative of that within the rumen of barren-ground caribou during the winter months. A second purpose was to compare results obtained using wet volume and air-dry weight as methods of measurement.

TABLE 1. — Percentage composition by volume and weight of forage from the rumens of six barren-ground caribou, as determined by different sieve mesh sizes

Food Item	Percent by volume			Percent by weight		
Screen mesh size:	4	7	10	4	7	10
Cladonia spp.[1]	45.5	47.7	52.3	43.1	43.4	46.4
Cladonia spp.[2]	3.4	3.1	2.7	3.2	2.9	2.4
Peltigera spp.	2.9	3.3	3.2	1.9	2.5	2.6
Cetraria spp.	1.2	.9	.8	1.0	.8	.7
Stereocaulon spp.	.8	1.3	1.8	1.3	1.8	2.7
Usnea sp.	tr	tr	tr	.1	tr	tr
Lichens	53.8	56.3	60.8	50.6	51.4	54.8
Grasses and sedges	10.9	8.3	6.6	6.5	5.1	4.1
Equisetum spp.	.2	.1	.1	.2	.1	.1
Grass and grass-like plants	11.1	8.4	6.7	6.7	5.2	4.2
Vaccinium vitis-idaea v. *minus*	3.1	3.3	2.8	3.9	4.1	3.4
Vaccinium myrtilloides	1.3	1.0	.7	1.3	1.0	.7
Vaccinium uliginosum	1.8	1.3	1.0	2.0	1.5	1.1
Ledum groenlandicum and *L. decumbens*	4.7	4.5	3.8	4.4	4.3	3.6
Salix spp.	.1	.1	tr	.2	.1	.1
Empetrum nigrum	tr	tr	tr	tr	tr	.1
Andromeda polifolia	.6	.5	.4	.6	.5	.4
Chamaedaphne calyculata	tr	tr	tr	tr	tr	tr
Betula glandulosa	tr	tr	tr	.1	.1	.1
Picea spp.	4.1	5.1	5.5	6.7	8.5	9.4
Larix laricina	tr	tr	tr	.1	.1	.1
Pinus banksiana	1.6	1.6	1.6	3.0	3.1	3.1
Woody plants	17.3	17.4	15.8	22.3	23.3	22.1
Bryophytes	3.4	3.4	3.1	2.3	2.3	2.1
Fungi	.4	.4	.3	.3	.3	.2
Others	3.8	3.8	3.4	2.6	2.6	2.3
Unidentifiable material	14.0	14.1	13.3	17.8	17.5	16.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

[1]This group included the "reindeer" lichens such as *Cladonia alpestris*, *C. mitis*, *C. rangiferina*, and *C. uncialis*.

[2]This group included the so-called cup and horn lichens such as *Cladonia cornuta* and *C. gracilis*.

PROCEDURE

Rumen samples were obtained from Manitoba during December, 1960, and frozen until used in the study. In the laboratory, the rumen contents were thawed, thoroughly mixed, and 250 ml was selected as a sample. Each rumen sample was washed through a gang of three sieves with the following mesh openings:

(1) 4.76 mm (sieve series mesh No. 4)
(2) 2.83 mm (sieve series mesh No. 7)
(3) 2.00 mm (sieve series mesh No. 10)

After sufficient washing and agitation to assure that only proper sized particles were retained on the mesh, the particles from each sieve were placed in shallow pans of water, and the particles of each plant species were separated with tweezers. Magnification was used as an aid in separating the particles from the smallest size mesh. The volume of the separated material was measured by water displacement to the closest 0.1 ml, after excess surface moisture was removed by blotting lightly. The material was then air-dried at room temperature for approximately 72 hours, and weighed to 1 mg accuracy on a Mettler, Type H5, balance.

Results and Conclusions

The volumetric data obtained from the largest mesh size and the cumulative, weighted percentages for the other two mesh sizes, for six rumen samples, are presented in Table 1. Corresponding gravimetric data are tabulated in Table 1, also. It is evident that data obtained from the larger mesh sizes could be inaccurate and misleading. The proportion of lichens generally increased as the mesh size became smaller. The proportion of lichens in the sieve with the largest mesh, therefore, was generally less than if the smaller plant particles were analyzed. On the other hand there were more plants of the graminoid group in the large meshed screen. While it cannot be assumed that forage particles of any one size have the same species composition, the particles from these three screens were probably reasonably representative of the recently ingested forage. Therefore, the data from the three screens for each sample were combined to give a cumulative percentage composition. Cumulative, weighted percentages were obtained by totalling the weight or volume of each forage species from the screens and that figure was divided by the total of all the forage found within those screens. Cumulative, weighted percentages were also desirable since the weight or volume of forage retained on the meshes was variable among sieves and among samples. Because lichens are easily fragmented and pass through the smallest mesh there is a tendency for the percentage of lichen composition to be underestimated. Conversely, woody tissues, such as pine needles, and graminoid tissues are more resistant to fragmentation and their percentage composition may be overestimated.

These results are in contrast to those of Dirschl, who studied sieve mesh size in relation to the food habits of pronghorn antelope. Dirschl (1962, p. 327-328) concluded "It is apparent that there is very little difference in the mean compositions found by means of these meshes. Thus the choice of any of these three mesh sizes for quantitative analysis of rumen contents does not affect the results to any extent." The present tests demonstrate that in analyzing barren-ground caribou rumen contents there can be differences in the composition of food species determined by the use of different mesh sizes. The diversity of plant material eaten by the two species might be the reason for the differing results obtained in the studies. In particular, the ease with

which lichens are fragmented may account for the smaller mesh size required to give reliable results when analyzing the forage composition from caribou rumens. Of the three meshes tested in the present study, the 2.00 mm mesh size would appear to give the best estimate. Use of mesh sizes smaller than that would make separation of species much more time consuming and their identification difficult.

A comparison of volumetric data and gravimetric data (Table 1) from the same samples indicates that volume tends to provide higher percentage composition figures for lichens and lower figures for woody plants. This indicates that lichens have a slightly lower weight per unit volume than the woody tissues. The only lichen group, in the weighted averages of the six samples, for which volume measurements did not provide a higher figure was *Stereocaulon*. This was anticipated since production studies had previously indicated that *Stereocaulon* was more dense than the other major forage lichens. Comparison of species present in small quantities is not warranted since volumetric analyses were less sensitive than weight when measuring very small amounts.

Gravimetric methods had several advantages over volumetric procedures in this food habit study. In addition to being more rapid, weight values are more easily related to forage production studies, utilization studies, and nutritive values obtained by chemical analysis of forage. These are usually expressed in terms of air-dry weights. Volumetric procedures also have mechanical disadvantages, such as surface tension between small fragments and the water surface, and the need for blotting to remove excess water from the tissues to be measured. In light of the advantages offered by gravimetric methods, it is surprising that many rumen analyses found in recent literature are based on volumetric analysis.

SUMMARY

A study was undertaken to determine which of three sieve mesh sizes could best be employed to determine the percentage composition of forage samples from the rumens of six barren-ground caribou. The second purpose was to compare the results obtained using wet volume and air-dry weight as methods of measurement. Of the meshes tested the smallest, with openings of 2.00 mm, appeared to provide the best results.. Gravimetric procedures offered advantages over volumetric ones.

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STUDIES OF THE BYRON BOG IN SOUTHWESTERN ONTARIO. XXVII. INSECTS ASSOCIATED WITH FLOWERING BLUEBERRY, *VACCINIUM ATROCOCCUM* (GRAY) HELLER

WILLIAM W. JUDD
Department of Zoology, University of Western Ontario, London, Ontario

THE BYRON BOG has been described by Judd (1957). In 1956 a study was made of the succession and duration of blooming of plants (Judd, 1958) including the Black High-bush Blueberry, *Vaccinium atrococcum* (Gray) Heller, in which blooming occurred from May 26 to June 8. In 1965 a study was conducted to determine the period of blooming of this plant in that year and the seasonal distribution of the insects visiting the flowers while they were in bloom.

A feature of *V. atrococcum* is that the flowers open before the leaves expand (Fernald, 1950). Beginning about May 9 in 1965 clusters of flower buds swelled noticeably. On May 15 flower buds on bushes in deep shade were still short, buds on bushes in partial shade had achieved their full length, one-quarter inch, and buds on bushes in full sun were of their full length with one or two corollas in bloom in each cluster. On succeeding days blooming was vigorous and on May 27 mature corollas were blown off many bushes during a storm. On June 1 most flowers had lost their corollas, and green berries, one-eighth inch in diameter, had formed below the calyxes. By June 6 only a few buds were still unopened, these being on bushes in deep shade. By June 8 all blooming was completed. Thus flowers in bloom were present on the shrubs for 24 days, from May 15 to June 7.

During the period of blooming the plants were examined for insects visiting the flowers in the early afternoon. The only insects collected were those actually seen feeding at the flowers or gathering pollen. They were captured either by netting with a net or by clapping them between the lid and jar of a poison jar. All insects captured were dusted with pollen, especially the bees in which the pollen baskets were filled. Thus all the species collected were either potential or actual pollenizers of the flowers. The insects were pinned and labelled and were identified by M. Ivanochko (Vespidae) and H. E. Milliron (other Hymenoptera) of the Entomology Research Institute, Department of Agriculture, Ottawa. All specimens are deposited in the collection of the Department of Zoology, University of Western Ontario except those noted as "kept" in the Canadian National Collection.

ACCOUNT OF INSECTS COLLECTED

The following list shows the numbers of each species collected and the dates of collection. These dates extend from May 18, three days after blooming began, to June 5, two days before blooming ended.

HYMENOPTERA

VESPIDAE

Vespula arenaria (Fab.) — 4: May 18, 20, 24.
Vespula vulgaris (L.) — 1: May 22.

These two species were previously taken in a baited trap in 1956 (Judd, 1962) on the bog. *V. vulgaris* is a widespread Nearctic species and *V. arenaria* is found in the Boreal region (Miller, 1961).

Ancistrocerus spp. — May 22, 24.

ANDRENIDAE

Andrena bradleyi Vier. — 2: May 22, 24 (kept).
Andrena carlini Ckll. — 1: June 4.
Andrena ? carolina Vier. — 5: May 19 (3 kept), May 31.
Andrena fragilis Sm. — 1: May 20 (kept).
Andrena vicina Sm. — 9: May 18 (kept), 22, 24 (kept), 26, 30 (1 kept).

HALICTIDAE

Dialictus spp. — 5: May 18, 20, 22, 27.

All species collected in Andrenidae and several species of *Dialictus* have been previously reported as visiting a wide range of flowers in Ontario (Knerer and Atwood, 1962, 1964). *Andrena bradleyi*, *A. carlini*, *A. carolina* and *A. vicina* have been recorded from *Vaccinium* in particular (Knerer and Atwood, 1964).

MEGACHILIDAE

Osmia atriventris Cr. — 1: May 19.
Osmia coerulescens L. — 1: May 27 (kept).

These species are recorded as widely distributed in eastern North America by Muesebeck *et al.* (1951).

APIDAE

Nomada sp. — 1: May 22.
Ceratina dupla Say — 1: May 26.
Bombus affinis Cr. — 3: May 26 (1 kept), 27.
Bombus bimaculatus Cr. — 7: May 19, 20 (kept), 22, 27, 28 (kept), June 1 (kept), 3.
Bombus griseocollis (DeG) — 1: May 24.
Bombus impatiens Cr. — 2: May 27, June 5.
Bombus perplexus Cr. — 2: May 18, June 1.
Bombus sandersoni Fkln. — 1: May 26 (kept).
Bombus vagans Sm. — 1: May 28.
Psithyrus citrinus (Sm.) — 1: May 30.

All species collected in this family are recorded as being visitors at flowers (Muesebeck *et al.*, 1951). *Ceratina dupla* was collected previously from marsh marigold at London by Judd (1964). All species of *Bombus* collected are recorded as being widespread in eastern North America by Muesebeck *et al.*

(1951). *Psithyrus citrinus* is an obligate social parasite on bees of the genus *Bombus* and is recorded from northeastern North America (Muesebeck *et al.*, 1951).

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REVIEWS

Marine Mammals of California

By Anita E. Daugherty. California Dept. Fish and Game, Sacramento. 1965. 87 pp. illus. $0.50 (U.S.).

While there is a wide array of technical literature dealing with seals, otters, porpoises and other marine mammals of the North Pacific Ocean, there is a notable lack of accurate, illustrated volumes comprehensive enough to be of use to the field naturalist. A small paperbound booklet by Miss Daugherty, a Fish and Game biologist, meets these qualifications.

This is not simply a faunal enumeration of species found only off California as Miss Daugherty implies in her title, because few animal species, especially whales, respect political boundaries. The association of the grey whale, Pacific striped dolphin, northern right-whale dolphin, harbour porpoise, Dall porpoise, Baird beaked whale, perhaps Hubbs beaked whale, northern fur seal, Steller and Californian sea lions, harbour seal and the sea otter, along with more wide ranging whales and seals, is distinctive. This fauna is found not only off California but through much of the transitional water mass from central Baja California northward to American and Canadian waters and beyond. Some species are found in other parts of the Pacific, but in the Transitional Domain all of these animals are commonly found together. The waters off the coast of British Columbia are part of this same water mass, therefore Miss Daugherty's account will be of use to Canadian naturalists.

Published by the State of California in a convenient format, this handbook fills a large void for it is the ideal shipboard companion for those who wish a pictorial guide to whales, dolphins and seals. One of the positive features is the well-executed set of drawings by Mr. Phil Schuyler. The text gives enough information to satisfy those who ask most of the general questions.

There are introductory chapters that give background on the biology of marine mammals, a detailed drawing of each species as it appears in life, and a statement of size, coloration, food, distribution, abundance and other information. Twenty-five species of cetaceans, seven species of pinnipeds and the sea otter are thus covered. A special section deals with "the sea lion controversy": Do sea lions eat significant amounts of commercially important fishes? The answer is not forthcoming but Miss Daugherty points out that they also eat lampreys, serious predators of salmon. The drawings are supplemented by six photographs of typical species, two skull drawings and a key to tooth counts of skulls as an aid to identification. The lay reader will find a list of the meanings of scientific names and twenty-two references for further study.

A few grammatical lapses, some misspellings and mistakes mar the booklet. Admittedly for the nonspecialist, this guidebook is not the place to introduce new information without factual verification and reference. The specialist will recognize new data on the distribution of Cuvier's beaked whale, pygmy sperm whale and others but will bemoan the lack of documentation.

Herein the shipboard observer working off the Canadian west coast will find diagrams of whale spouts (borrowed from a similar booklet by Gordon Pike) and illustrations of each species and information to verify his identification. The beachcomber will find useful data for identifying skulls and live animals. And the answers to a number of questions are available by simply flipping the pages (there is a table of contents but no index). One of the biggest attributes

of this little book is its size: only 5 by 6½ inches, it easily slips into a pocket. There should be no excuse for not having it at hand when next you sight a porpoise.

EDWARD MITCHELL

Fisheries Research Board of Canada
Arctic Biological Station
Ste. Anne de Bellevue, Quebec

The Lily Family (Liliaceae) of British Columbia

By T. M. C. TAYLOR. Handbook No. 25 of the British Columbia Provincial Museum, Dept. of Recreation and Conservation, Victoria, B.C., 1966. 109 pp., 44 fig., 42 maps. $0.50.

To the series of handbooks on the flora and fauna of British Columbia, Dr. Taylor has contributed this excellent volume on the Liliaceae. The twenty-four genera and forty-six species recognized are treated alphabetically. There are short generic descriptions, short species descriptions and notes on habitat, season, overall range, distribution in British Columbia and pertinent comments for each species. All but two are illustrated by full-page line drawings. Two-thirds of these illustrations are very striking, white on a black background. One wonders why they were not all done in this manner. Some accuracy is lost however, in the use of cross-hatching in place of shading in these drawings. It is perhaps unfortunate that *Calochortus lyallii* is not illustrated. Although this species has only been collected but once, and that fifty years ago, this does not eliminate the possibility of its turning up again. *Zygadenus gramineus* is noted as being doubtfully distinct from *Z. venenosus*. Again it is unfortunate that the latter is not illustrated so that the reader can distinguish the two taxa for himself.

Distribution maps depicting the range of each species in British Columbia are conveniently arranged alphabetically following the descriptive part of the text. These are followed by a short glossary of technical terms, which will make the book more useful to the beginner, an abbreviated list of literature references which would be useful to a student of the flora of the province and indexes to latin and colloquial names. Other volumes in the series, with prices, are listed on the inside back cover.

W. J. CODY

Plant Research Institute
Central Experimental Farm
Ottawa, Ontario

Bugs or People

By WHEELER MCMILLAN, Appleton-Century, New York, 1965. 228 pp. In Canada: General Publishing Co. Ltd., 30 Lesmill Road, Don Mills, Ontario. $5.95.

The author gives a good historical review of the progress of modern agriculture and of the problems that would ensue if pesticides were not used — without mentioning how commercial crops were grown in the past without the present level of heavy use.

Even an experienced agricultural writer can get into trouble when he tries to deal with the pesticide problem. The author discusses careful agricultural use of chemicals and freedom from wildlife losses. He cites gulls as unharmed scavengers, apparently unaware of gull losses on the Great Lakes in 1963 and 1964 caused by pesticides from agricultural use building up in the food chains. He repeats the statistics of how many more people are killed by automobiles than by pesticides but carefully avoids mentioning that use of autos is optional while use of food is not, so the pesticide victim does not have the option of avoiding damage. His comparison of reaction against pesticide use with acceptance of unsafe cars makes surprising reading when declining sales of autos are attributed to their inability to meet public demand for safety.

No one objects to pesticides or their proper use but thinking persons would like to see them more specific in action so they will do the required job with fewer side effects on other parts of the fauna. The book is not an answer to *Silent Spring* or *Pesticides and the Living Landscape*.

V. E. F. SOLMAN

Canadian Wildlife Service
Ottawa, Ontario

Vascular Flora of British Columbia — preliminary check list

By T. M. C. TAYLOR, Dept. of Botany, University of British Columbia, Vancouver 8, B.C., 1966. 31 pp. processed.

There is a great need for a modern flora of British Columbia. Students of botany in that province have only the now sadly out-of-date Flora of southern British Columbia published in 1915 by J. K. Henry, to which J. W. Eastham added his "Supplement" in 1947, or the floras of adjacent areas of Alberta, Alaska and northwestern United States.

A decisive step towards a new flora is the publication of the present list and Dr. Taylor is to be commended for it. In the list a total of 112 families, 623 genera and 2216 species are recognized. Of the latter 340 marked by an asterisk are adventives that appear to be established. The list is divided into three sections: Pteridophyta, Gymnospermae and Angiospermae. Within each of these, the families, genera and species are listed alphabetically. To one familiar with the Englerian system, it is somewhat disconcerting to find the Cyperaceae next to the Cucurbitaceae but for students using the book for quick reference, the alphabetical sequence might be said to be more convenient. No subspecific taxa are recognized, but at least some entities are treated at the specific level which by other writers are considered to be of lesser rank e.g. *Polypodium glycyrrhiza* (*P. vulgare* ssp. *occidentale*) and *Polypodium hesperium* (*P. vulgare* ssp. *columbianum*). There are some errors in spelling and in a few cases the authorities are omitted but these do not greatly lessen the value of the catalogue.

W. J. CODY

Plant Research Institute
Ottawa, Ontario

Our Natural World

Compiled and edited with comments by HAL BORLAND. Doubleday and Company, Inc., Garden City, New York, 1965. 843 pp. *In Canada*: Doubleday Publishers, 105 Bond Street, Toronto 2. $11.50.

Naturalists, their likes and dislikes are all different. Hal Borland has made such a wide choice of the natural history literature of America in the hundred odd selections grouped in this book that whatever your interest may be, you will find it included.

Because of his own long experience in the field and his ability as a writer he has chosen the best from the works of some 90 authors. The familiar passages from well-known writers like Thoreau, Teale and Leopold are interspersed with writings by many less well-known naturalists. There are also works by a group of authors including David Crockett, Mark Twain and Washington Irving who are not commonly regarded as nature writers.

The quotations are grouped under headings – the woodlands, the watery places, the plains and deserts, the mountains, animals, birds, insects and plants and trees. They include historical material, carefully recorded observations and fictional treatments. A number of line drawings by Rachel Horne add to the reader's pleasure.

All naturalists, amateur and professional alike will find here things of enjoyment and interest. They will thank Hal Borland for the care and wisdom shown in his selections.

V. E. F. SOLMAN

Canadian Wildlife Service
Ottawa, Ontario

Wildlife Biology

By RAYMOND F. DASMAN. John Wiley and Sons Inc., New York. 1964. 231 pp. $5.95 U.S.

This book is in the tradition of Aldo Leopold's *Game Management* of 1933 and Durward Allen's *Our Wildlife Legacy* of 1954. It is a university-level text in ecology that is, like the other two, well enough written to be read for enjoyment.

After tracing two hundred years of wildlife history in California, from wild abundance to scarcity and finally to managed abundance, the author deals with the more general subjects of habitat, migration, population dynamics, regulation of wild populations, land use and its impact, and methods of studying wildlife. Population discussion includes the human population problem as well as the way we mis-manage various wild populations we try to control.

Every thinking citizen of North America could profit from reading this book.

It is a pleasure to review a book in which the author says so well so much that needs to be said.

V. E. F. SOLMAN

Canadian Wildlife Service
Ottawa, Ontario

OTHER NEW TITLES

Hurry Spring!

By STERLING NORTH. Drawings by Carl Burger. E. P. Dutton & Co., Inc., N.Y. 1966. 58 pp. *In Canada*: Clarke, Irwin & Co., Ltd. $4.65.

Those who enjoyed the warm, often nostalgic, prose of *Rascle* will find the same hand at work here. Although the publisher claims an audience from "nine to ninety", some of the text is more obviously appealing to younger readers while other parts — such as the author's remembered feelings at age seven on the death of his mother — are a bit poignant for them. The book could have been, more aptly, titled "fragments of North" as this selection of random comments on nature, the coming of spring, and personal boyhood reminiscences makes a slender volume (58 pages) for the price ($4.65). One can not help but wish for longer contributions from Mr. North's pen — a full length account of his boyhood and family is certainly due his readers now.

The Sense of Wonder

By RACHEL CARSON. Photographs by Charles Pratt and others. Harper and Row, Publishers, New York and Evanston. 1965. 95 pp. (In Canada: Longmans Canada, Ltd., Don Mills, Ontario. $6.25).

Miss Carson intended, the publishers tell us, to expand the brief text that accompanies these photographs of nature in black-and-white and in colour, but time ran out for her. It remains a simple yet effective tribute to her own appreciation of the natural world.

Nature and the Camper: A Guide to Safety and Enjoyment for Campers, Hikers, and Fishermen on the Pacific Slope and the Southwest Deserts

By MARY V. and WILLIAM HOOD. The Ward Ritchie Press. 1966. 157 pp. (*In Canada*: General Publishing Co. Ltd., Don Mills, Ontario).

Although most of the text applies specifically to the southwestern United States, the general information included will be of interest and value for the intended audience anywhere. A quick review of the essentials of such topics as rabid and poisonous animals—recognition and what to do if bitten—are among the many pertinent topics competently covered.

The Evolution of the Mammals of the Queen Charlotte Islands, British Columbia

By J. BRISTOL FOSTOR. Occasional Papers of the British Columbia Provincial Museum No. 14. 1965. 130 pp.

Marine Algae of British Columbia and Northern Washington, Part 1: *Chlorophyceae* (Green Algae).

By ROBERT F. SCAGEL. Queens Printer. Ottawa. 1966. National Museum of Canada Bulletin 207, 257 pp.

A Preliminary Report on the Effects of Phosphamidon on Bird Populations in Central New Brunswick.

By C. DAVID FOWLE. Canadian Wildlife Service Occasional Papers No. 7. Queens Printer, Ottawa. 1965. 54 pp.

Plants of the Mackenzie River Delta and Reindeer Grazing Preserve

By W. J. CODY. Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa. 1965. 56 pp. (Copies available from W. J. Cody, Plant Research Institute.)

A Survey of the Vascular Plants of Lambton County, Ontario

By LULO O. GAISER, compiled by RAYMOND J. MOORE. Plant Research Institute, Research Branch, Canada Department of Agriculture, Ottawa. 1966. 122 pp. (Copies available from R. J. Moore, Plant Research Institute.)

JOURNALS RECEIVED

Boissiera.

Volume 11. Conservatoire et Jardin botaniques, Ville de Genève. 1965.

Biota.

Volume V, No. 42. Lima, Peru. March 1965.

Candollea.

Volume 20. Organe des Conservatoire et Jardin botaniques de la Ville de Genève. 1965.

Biologica.

Fasciculo XXXVI. Instituto de Biologica "Juan Noe" de la Facultad de Medicina de la Universidad de Chile. July 1964.

Revista del Museo de Historia Natural de Mendoza.

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Fasciculo XXXVII. Instituto de Biologica "Juan Noe" de la Facultad de Medicina de la Universidad de Chile. July 1965. 94 pp.

Candollea. Organe des Conservatoire et Jardin Botaniques de la Ville de Genève. VOLUME 21/1. Genève, 1966.

NOTES

Life History Notes on the Goldeye, *Hiodon alosoides* (Rafinesque), in the North Saskatchewan River in Alberta

As part of a study of the limnology of the North Saskatchewan River in the vicinity of Edmonton, Alberta, the fish fauna was examined during 1964 and 1965. This brought to light certain aspects of the ecology of the goldeye which warrant attention. The goldeye was often captured by anglers when still-fishing using worms or insects for bait. Adults of the species were the most abundant fish in gill net catches, outnumbering all other species combined.

The North Saskatchewan River is very swift. It is nearly impossible to set a gill net in the current, so nets were set in the mouths of two tributaries and in one blind channel of the river. When the river is high, as during the spring and summer, these sites contain what is essentially river water and fish are attracted to them because of the reduced current.

In 1964 nets were not set until June 19, when goldeye were found to be abundant. In mid-July they were very common, but from August 1 onwards they were absent. In 1965, the goldeye was not taken in nets set on June 4, but were present during mid-July. Anglers were rarely observed to capture the species before the last week in May. The movement into the river near Edmonton might be partially temperature dependent as they are not found until the water warms rapidly to 10 or 12°C.

Of 76 goldeye taken in the nets, the age range was 4-8 years, with a fork length range of 30.6 – 39.2 cm. The age-length relationships of some of the specimens is shown below.

Age		Length range in cm	Mean	Number of specimens
4	male	30.6–33.8	32.4	4
	female	—	—	0
5	male	31.1–35.1	32.8	20
	female	—	—	0
6	male	32.2–36.3	34.2	13
	female	33.0–38.1	34.9	5
7	male	34.5–35.2	34.7	3
	female	34.7–39.2	37.3	3
8	male	—	—	0
	female	—	38.8	1

At any given age the females seem to be somewhat larger than the males. Many goldeye taken by anglers were examined, but only one specimen younger than four years was observed. This was estimated to be three years old. It is thought unlikely that the younger age classes were missing because of differential capture technique, as the nets varied in size from $\frac{3}{4}$ inch to $4\frac{1}{2}$ inches stretched mesh.

When goldeye were first examined in the spring the gonads were small. They increased in size throughout the summer, but when the first fish were taken the next spring there was again no evidence of spawning. Sprules (1947) found that the goldeye in the Saskatchewan River in Manitoba entered marshy areas and spawned immediately after breakup in the spring. By August young goldeye, 6.3 cm in length, were abundant in the river. There are no marshy regions connected to the river near Edmonton and the adults do not seem to be present in the area until one month after breakup.

In the present study more than 15,000 fish were captured with a commonsense seine. Seining was done in all habitats found in the area. It seems unlikely that young goldeye, if present, would be missed. This leads to the conclusion that the adult fish do not spawn in the area, and in fact do not frequent this stretch of the river until they are three or four years old. Reed (1962) has shown that

there is a yearly upstream migration in the North Saskatchewan River in the spring and a corresponding downstream migration in the fall. It seems likely that the fish found near Edmonton spawn further downstream and then move into this region during the summer. This is of interest, as it is unusual for a fish species to continue what was initiated as a spawning migration for the express purpose of feeding.

Of 64 specimens in which the sex was determined it was found that the ratio of males to females was 51/13, which suggests that more males move upstream than do females.

SPRULES, W. M. 1947. A management program for goldeye (*Amphiodon alosoides*) in Manitoba's marsh regions. Canadian Fish Culturist 2(1):9-12.

REED, E. B. 1962. Limnology and fisheries of the Saskatchewan River in Saskatchewan. Department of Natural Resources, Government of Saskatchewan, Fisheries Report No. 6. 48 pp.

COLIN G. PATERSON

Department of Zoology
University of Alberta
Edmonton, Alberta
18 February 1966

First Canadian Record of the Brackish Water Anthozoan *Nematostella vectensis* Stephenson

Nematostella vectensis is a small (10-20 mm) anthozoan that was discovered on the Isle of Wight, England, and first described in 1935 by Stephenson (British sea anemones, The Ray Society, London). Subsequently it was reported by Crowell (1946, Journal Washington Academy of Sciences 36(2): 57-60) from a brackish pond at Woods Hole, Massachusetts, and more recently by Hand (1957, Journal Washington Academy of Sciences 46(12): 411-414) from a marsh pond in San Francisco Bay, California. In the intervening years it has been found in shallow brackish pools over much of the British Isles and along the West Coast of North America from Southern California to Puget Sound (Cadet Hand, personal communication, November 1965). On October 14, 1965, this unusual anemone was discovered quite by accident in two brackish ponds on the shores of the Minas Basin near Canning, Kings County, Nova Scotia. This is the first Canadian report and apparently the second locality record for the Atlantic Seaboard of North America. (Sears Crowell, personal communication, December 1965).

The two small ponds from which specimens were collected are located in *Spartina* marshes that border the south side of the Canning River one mile east of the town of Canning. Associated with the tremendous local tidal range of nearly thirty feet are the steep sided gullies which deeply dissect and thoroughly drain most of these salt marshes. Brackish ponds are rather the exception in this habitat. Of the two ponds in question, one contained masses of *Cladophora* and *Chaetomorpha* algae and the other was dominated by the pondweed *Ruppia* sp. The anemone was found in mats of both plants as well as in the pond bottom ooze. *Nematostella vectensis* does not attach to firm substrata but rather lies buried with only a short portion of the body exposed with its whorl of sixteen transparent tentacles spread out. At the time of our local discovery, the authors were searching for marine gastropods and in disturbing the algae and the substratum many tiny white symmetrical "blobs" were noticed drifting in the water. Upon closer examination these objects appeared to be minute anemones. Fortunately the "Keys to the Marine Invertebrates of the Woods Hole Region" (R. I. Smith, Editor, 1964) was at hand and tentative identification to *Nematostella* was later confirmed from specimens sent to Dr. Cadet Hand.

It may well be that *Nematostella* occurs in other salt marshes of eastern

Canada and should be looked for. When expanded it has the appearance of a typical sea anemone and possesses 16 tentacles and 8 mesenteries, but it is nearly transparent and even in an aquarium it is inconspicuous. However, when disturbed it contracts and becomes a conspicuous squat, pale grey mass. Examination under a dissection microscope will reveal the presence of hundreds of nematosomes which are known only from this genus. (For illustrations of the anatomy the reader is referred to Crowell 1946). Each nematosome is a found mass (30 microns) of flagellated cells bearing nematocysts and can be found swimming about the enteron and out into the cavities of the tentacles. The function of these bodies has not been determined.

The authors successfully preserved specimens by allowing them to expand in a petri dish of seawater and then anaesthetizing by adding a generous amount of magnesium sulphate crystals. In three or four hours the anemones no longer responded to touch, and were then flooded with 5% neutral formalin. Our best expanded specimens were prepared by gently injecting the preservative into the enteron of the relaxed *Nematostella* by a fine hypodermic inserted through the pharnyx. The result is a ballooned transparent specimen with eight well defined mesenteries.

Permission to use the unpublished distributional data supplied in correspondence with Dr. Cadet Hand, University of California, Berkeley, for the West Coast area; and from Dr. Sears Crowell, Indiana University for the East Coast, is gratefully acknowledged. This investigation was financed in part by Canadian National Research Council Grant A-2009.

KANIAULONO BAILEY
J. SHERMAN BLEAKNEY

Department of Biology
Acadia University
Wolfville, Nova Scotia
24 January 1966

Mockingbirds in New Brunswick

RECENT notes on sightings of Mockingbirds, *Mimus polyglottos*, in Alberta and of breeding Mockingbirds in Newfoundland (Canadian Field-Naturalist 79(3): 208-209) have prompted me to submit these observations.

Over the last several years the Mockingbird has been reported more and more frequently in New Brunswick—usually in southern parts though it has been reported as far north as Fredericton. A total of four were reported in the 1965 New Brunswick Christmas Bird count (Nature News, New Brunswick Museum, January 1966) and my own records go back to 1961.

I had seen this species several years ago at Point Pelee, Ontario, and about Montreal, P.Q.; so I recognized it in 1961 at first sighting at St. Andrews, N.B., on December 2. This single bird remained here for the winter and was last seen about mid-May, 1962 by Dr. Neil Bourne, then on the staff of the Fisheries Research Board's Biological Station. In this interval I saw it myself eight to ten times as did a number of other people. It spent a good deal of time about the garden property of Dr. John Hart here in St. Andrews. It was noticed feeding on small rose hips and on frozen apples. In his note referred to above MacGillivray mentioned apples as a favourite item in the Mockingbird's diet.

It is not known whether our 1961-62 visitor fell victim to a cat or some other predator or simply went elsewhere.

In 1964 a single Mockingbird was seen at St. Andrews by Dr. Bourne, September 30. Another one was seen at St. John, October 17-18 and still another at Sackville, October 24-25 (Nature News, N.B. Museum, November 1964).

In 1965 I first saw a Mockingbird a few blocks from my home on November 10. It was eating small rose hips in a hedge. On November 14 two birds flew to the same hedge. Later one bird came at intervals to a small apple tree near my back

door and both birds were seen together close to my house four times. The last time, November 28, after flying about, they finally alighted on the lawn about four or five feet apart, facing each other and with their tails cocked up—quite a pugilistic attitude. A single bird came six times during December, the last date December 24.

During December and until January 20, 1966, one bird quite regularly visited the apple tree and feeder of Miss Jacqueline Davis, who lives eight blocks from my home. There was no evidence to show whether both birds were still about.

No song was heard but more than once a bird was heard to give a series of emphatic calls or scolding notes quite similar to those of the Brown Thrasher.

Three Sharp-shinned Hawks, two adults and one immature, have been seen about St. Andrews this winter. These predators may well be responsible for the disappearance of our mockingbirds since January 20.

Miss H. Willa MacCoubrey

78 Mary Street
St. Andrews, N.B.
28 February 1966

Seaside Sparrows in New Brunswick

The collection of a Seaside Sparrow (*Ammospiza maritima*) in the Cole Harbour-Chezzetcook, N.S., area (Canadian Field-Naturalist 79(3): 211-212) has finally and firmly established the occurrence of this species in our area. I was surprised to learn that this was the first for Canada because I have two sight records (see below) and feel sure there must be others with similar or better information that might be pooled now to give a fuller knowledge of this interesting species.

On September 16, 1951, at the St. Andrews town dump, which is on the edge of a small salt-water marsh, I saw a bird which I am quite satisfied was a Seaside Sparrow. It sat in full view on a pile of brush, and allowed me to study it with binoculars for about 10 minutes at approximately 40 feet. The two face markings were clearly defined against the otherwise dark head. It agreed in all particulars with the bird shown in Peterson's *Field Guide*, and was easy to distinguish from the Sharp-tailed Sparrows with which I am familiar. Unfortunately I had nobody with me to corroborate my identification.

On October 13, 1965, I again saw a Seaside Sparrow. This one was about the rocks of a sea-wall, at the landward end of the beach road, which at low tide gives access to Minister's Island, about a mile outside St. Andrews. On this occasion I immediately but vainly tried to contact Dr. John Rigby of St. Andrews, who is a competent "birder", in hopes of establishing a corroborated sighting record. Finally, when we did team up for the search, we could not find the bird again.

I am fully convinced that both these birds were Seaside Sparrows, though realizing that uncorroborated sightings cannot be accepted as official records.

Miss H. Willa MacCoubrey

78 Mary Street
St. Andrews, N.B.
28 February 1966

Redfish, *Sebastes marinus* var. *mentella*, from the Kennebecasis River, N.B.

On January 15, 1966, a fish was brought to the New Brunswick Museum for identification by Mr. Arthur Wright who had caught it on January 8 in the Kennebecasis River about one-half mile from Millidgeville.

The fish, caught on a hake line through the ice in 90 feet of water, was

deep red in color and proved to be a redfish, *Sebastes marinus* var. *mentella;* considered by some ichthyologists as a full species, *Sebastes mentella* (*see* Templeman 1959).

The specimen measured (standard length) 305 mm; the diameter of the eye 29 mm; from the eye to tip of snout 25 mm; color of eye reddish; chin sharp; the peritoneum black. The larger eye, the red color of the body and head and the protruding chin would place this specimen in the *mentella* variety.

The *mentella* variety is usually taken at greater depths than the *marinus* variety, so the capture of the *mentella* specimen in 90 feet of water and several miles from the open Atlantic proves interesting.

The Kennebecasis River is part of the Saint John River system and Millidgeville lies several miles above the Reversing Falls where the Saint John River empties into the Atlantic. The lower reaches of the Kennebecasis occupy a sunken river valley, separated from the sea by a sill, with extreme depths in excess of 200 feet. Although surface waters are only brackish the salinity at greater depths is about 22 per cent and hake, lumpfish and other marine species are caught through the ice in winter.

Sebastes marinus was listed by Perley (1852) as taken in the Bay of Fundy at Saint John in June 1851, long before varieties were recognized. Trites (1960) reported one redfish taken here 1957-58 but identified it only as *Sebastes marinus.*

The specimen obtained by Mr. Wright is now preserved in the New Brunswick Museum fish collection.

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W. A. SQUIRES
S. W. GORHAM

New Brunswick Museum
Saint John, N.B.
15 March 1966

A Summer Tanager in Manitoba

A Summer Tanager, *Piranga rubra rubra* (Linnaeus), was found dead on the Saskatchewan River shore of Rahl's Island, adjacent to The Pas, Manitoba, on May 25, 1966, by Mr. Harvey Anderson. The specimen was made into a study skin by Mr. Sam Waller and is in Mr. Waller's collection.

Through the kindness of Mr. Waller I have been able to examine the specimen. It is an immature male assuming first nuptial plumage and is referable to the nominate race. Mr. Waller noted that it appeared to be in breeding condition. There seems to be no previous valid record of this tanager in Canada west of southern Ontario.

W. EARL GODFREY

National Museum of Canada
Ottawa, Ontario
8 July 1966

The Western Painted Turtle near Gilbert Plains, Manitoba

IN 1958 the distribution of the Western Painted Turtle, *Chrysemys picta bellii,* in Manitoba was summarized by C. D. Bird (Canadian Field-Naturalist 72(1): 28-31). Concerning the central and western part of the province Bird reported it as "restricted to the Red River and its tributaries, the Rat, the Seine, the Assiniboine, the Souris, the Minnedosa and the Qu'Appelle rivers."

I had once seen a Western Painted Turtle on the bank of the Wilson River, about eight miles east of Gilbert Plains,

and had several reports of sightings in the Valley River. Francis R. Cook, to whom I reported these observations, advised me that Gilbert Plains was outside the known range of this species and requested further information and, if possible, a confirming specimen. Accordingly I collected a number of reports of sightings in the Valley River, the most valuable of which (from Mrs. Joe Gallant) was that of several juveniles sunning themselves on a boulder. I then arranged with some of the Brickburn school pupils to collect specimens.

In the late summer of 1966 I acquired two specimens which had been captured by David Kulchyski in the Valley River near the village of Gilbert Plains. These were sent to Francis R. Cook of the National Museum of Canada where they are catalogued as NMC 9514 (female) and NMC 9524 (male).

The Valley River rises in the Duck Mountain and discharges into Lake Dauphin, receiving in its course the waters of Pleasant Valley Creek from the Riding Mountain. Its elevation at the village of Gilbert Plains is approximately 1300 feet. The nearest previous locality reports for this turtle appear to be the Onanole and Riding mountain sites reported by Bird. Onanole, about 50 miles south of Gilbert Plains, is in the portion of the Riding Mountain drained by the Minnedosa River into the Assiniboine. Bird does not indicate the specific site of the Riding Mountain specimen except that it was in the Assiniboine drainage basin.

The principal streams rising in the Riding Mountain are the Birdtail Creek and the Minnedosa River, both discharging into the Assiniboine; the Whitemud River discharging into Lake Manitoba; and the Wilson, Vermilion, Valley, Ochre and Turtle rivers discharging into Lake Dauphin. There are numerous places where turtles could cross the height of land between the Assiniboine River and the Lake Dauphin drainage basins.

I have a further relevant report from Harold Kroll of Roblin, Manitoba, who saw one specimen in the Shell River about nine miles southeast of the town of Roblin, and three specimens together where Manitoba Highway No. 83 skirts Goose Lake just south of Roblin. These specimens were in the Assiniboine drainage basin but a considerable distance northwest of any previous reports.

JAMES L. PARKER

Gilbert Plains, Manitoba
24 August 1966

Clay-colored Sparrow Nesting at Ottawa, Ontario

As Snyder (1957) has pointed out, the Clay-colored Sparrow, *Spizella pallida*, is a western bird that is expanding its range eastward. Snyder (1942) recorded its first known breeding in Ontario east of Lake Superior, a small colony nesting at Little Rapids, near Thessalon, in 1931. Baillie (1957) summarized its nesting in southern Ontario: Halton County in 1950; Grey and Simcoe counties in 1952; and in Waterloo and Wentworth counties in 1955.

In the Ottawa region, the Clay-colored Sparrow was first recorded on May 20, 1954, when a singing individual was observed by several persons, including the writer. This was recorded by Mills (1957). Since that time the writer has noted single singing individuals in the region on July 1, 1961, and again on May 31, 1964. Farther east, the species has been recorded by Montgomery (1961) near Phillipsburg and Ste. Anne de Bellevue, Quebec, in spring, 1960; and by Cayouette (1962) who recorded an individual at Ste. Catherine, west of Quebec City, June 17 to July 5, 1962. South of Ottawa at Merrickville, a singing male was observed from July 1 to 10, 1951, by Terrill (1952). Some 250 miles

north of Ottawa, the writer collected a silent male near Amos, Quebec, on July 5, 1965.

Turning again to the Ottawa region: On May 22, 1966, Kenyon Ross and Paul Frigon observed three, possibly four, Clay-colored Sparrows near Uplands airport in Ottawa and secured good photographs. When I visited the airport vicinity on May 28, I quickly located at least three individuals there. Two singing males had established territories and one of them seemed paired with a third individual. Suspicious that they were breeding, I returned there on June 4. Eventually I flushed a Clay-colored Sparrow, apparently a female, from a six-foot-tall Scots pine, *Pinus sylvestris*, and in the thick branches located a well-hidden nest which contained four eggs. The male alternately fussed and sang near by. The female returned to the nest some fifteen minutes later. A hundred yards away, also in a young, low, pine plantation, another male sang regularly.

Also in 1966, the writer observed two additional singing Clay-colored Sparrows in the Ottawa region, one in Gatineau Park, Quebec, on May 28, and one near Blossom Park, Ottawa, on June 5. The latter was still present on June 12. The writer was absent from Ottawa for the remainder of June and by early July neither the Blossom Park nor the Gatineau Park birds could be found.

When I visited the Uplands airport nesting site on July 1, I was unable to re-locate the nest. Both parents, however, were very much in evidence. One carried a small caterpillar in its beak and both remained greatly agitated throughout the duration of my stay. On July 10 both males were singing but no further observations were possible due to my absence from Ottawa throughout the following five weeks.

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W. EARL GODFREY

National Museum of Canada
Ottawa, Ontario
28 September 1966

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Compiled by Mrs. G. R. Hanes

A NOTE ON THE PRODUCTION OF THIS JOURNAL

The *Canadian Field-Natuarlist* conforms to recommendations on the lay-out of periodicals issued by the International Organization for Standardization. It is set by linotype in Janson. The title is Kennerley. Boldface headings are Bodoni. Coverstock is 'Mayfair' by Howard Smith and text paper is Provincial Paper 'Thriftcoat'. The journal is printed by The Runge Press Limited, 124 Queen Street, Ottawa 4, Ontario.

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